Instructional Manual

PTV SERIES

High Voltage Power Supply

SPELLMAN

HIGH VOLTAGE ELECTRONICS CORPORATION

Spellman

High Voltage Electronics Corporation

Advancing High Voltage Technology for Tomorrow's Applications

Instructional Manual

PTV SERIES

High Voltage Power Supply

Model:	PTV50P200
Serial #:	C030955
Date:	05/11/00

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SAFETY

THIS POWER SUPPLY GENERATES VOLTAGES THAT ARE DANGEROUS AND MAY BE FATAL.

OBSERVE EXTREME CAUTION WHEN WORKING WITH THIS EQUIPMENT

High voltage power supplies must always be grounded.

Do not touch connections unless equipment is off and the capacitance of both the load and power supply are discharged.

Allow five minutes for discharge of internal capacitance of the power supply.

Do not ground yourself or work under wet or damp conditions

SERVICING SAFETY

Maintenance may require removing the instrument cover with the power on.

Servicing should be done by qualified personnel aware of the electrical hazards.

WARNING notes in the text call attention to hazard in operation of these units that could lead to possible injury or death.

CAUTION notes in the text indicate procedures to be followed to avoid possible damage to equipment.

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TABLE OF CONTENTS

		PAGE
1. INTRODUCTION		
1.1	DESCRIPTION OF THE PTV SERIES	1-1
1.2	PTV SPECIFICATIONS	1-1
1.3	STANDARD FEATURES	1-2
1.4	OPTIONS	1-3
1.5	INTERPRETING THE MODEL NUMBER	1-3
2. INSPECTION & INSTALLATION		
2.1	INITIAL INSPECTION	2-1
2.2	MECHANICAL INSTALLATION	2-1
3. OPERATING INSTRUCTIONS		
3.1	OPERATION	3-1
3.2	STANDARD FEATURES	3-3
4. PRINCIPLES OF OPERATION		
4.1	AC TO DC RECTIFIER AND ASSOCIATED CIRCUITS	4-1
4.2	HIGH FREQUENCY INVERTER	4-2
4.3	HIGH VOLTAGE CIRCUITS	4-2
4.4	CONTROL CIRCUITS	4-2
4.5	OPTIONS	4-2
5. OPTIONS		
5.1	FLOATING GROUND	5-1
5.2	220V AC SINGLE PHASE INPUT	5-1
5.3	NO SLOW START	5-1
5.4	NON-STANDARD SLOW START	5-1
5.5	EXTRA LENGTH OUTPUT CABLE	5-1
5.6	FOCUS	5-2
5.7	GRID	5-2
5.8	CUSTOM DESIGNED MODELS	5-2
6. MAINTENANCE		
6.1	PERIODIC SERVICING	6-1
6.2	PERFORMANCE TEST	6-1
6.3	HIGH VOLTAGE DIVIDERS	6-1
7. REPLACEMENT PARTS		
7.1	REPLACEMENT PARTS	7-1
7.2	CORRESPONDENCE AND ORDERING SPARE PARTS	7-1
7.3	RECOMMENDED SPARE PARTS	7-2

8. FACTORY SERVICE
8.1 WARRANTY REPAIRS 8-1
8.2 FACTORY SERVICE PROCEDURES 8-1
8.3 ORDERING OPTIONS AND MODIFICATIONS 8-1
8.4 SHIPPING INSTRUCTIONS 8-1

LIST OF FIGURES

Figure 2.1 Dimensions 2-2
Figure 3.1 Typical Operating Setup 3-2
Figure 3.2A Remote Programming Via Voltage Source 3-4
Figure 3.2B Remote Programming Via External Resistance 3-4
Figure 3.3 Remote Monitor 3-5
Figure 3.4 HV ON/OFF Control 3-5
Figure 3.5 OVP/Power Supply ON Indicator 3-5
Figure 5.1 Floating Ground Interface Circuit 5-2

LIST OF TABLES

Table 1.1 Options 1-4
Table 2.1 J2 Wiring 2-2

APPENDIX

A. Schematics
B. Specification Controls (Custom Models Only)

CHAPTER 1

INTRODUCTION

1.1 Description of the PTV Series:

The PTV series of high voltage power supplies provide very well regulated, low ripple, high voltage in a highly efficient, compact design. The dramatically reduced size of the PTV Module, compared to traditional high voltage modules, is obtained by a state of the art off-line resonant converter. The resonant converter utilizes a unique control scheme which allows constant frequency operation while maintaining high efficiency. The high efficiency is obtained by zero current switching (ZCS) resonant control. High operating frequency, typically 60KHz, allows for very low ripple and excellent dynamic response capabilities.

The DC output voltage and current are controllable over the full range of operation. Monitoring and control signals are provided for simple yet flexible control of the power supply. The PTV series operates from 115VAC +/-10%, or 220VAC +/-10%, at 50/60Hz single phase. (User should specify input voltage at time of ordering). The PTV series operates at 200W continuous without the need for forced air cooling. The ambient temperature must be kept below the maximum rating as specified in 1.2. Consult Spellman Sales Department for higher power capabilities of the PTV series (up to 600W peak).

The standard warranty applies to the PTV modules. Consult factory about the warranty for custom PTV modules.

1.2 PTV Specifications

Output Control: Voltage and current are externally programmable over the entire range from zero to maximum rating via 0-10VDC reference or potentiometer. (Other scale factors for control and monitoring can be provided i.e. 1 volt per 10KV, 1 volt per 10mA.etc).

Input Voltage: 115VAC +/-10%, 50/60Hz, single phase. (220VAC +/-10%, 50/60Hz, single phase, internally switchable). Consult factory for other than 115VAC input voltage.

Voltage Regulation:

Load Regulation: 0.01% of full voltage for a no load to full load change.

Line Regulation: +/-0.01% of full voltage over the specified input voltage range.

Current Regulation:

Load Regulation: 0.05% +/-25uA from 0 voltage to full voltage.

Line Regulation: +/-0.01% of full current over the specified input voltage range.

Ripple: 0.1% P-P of output voltage.

Polarity: Positive or Negative polarity with respect to ground. (Specify at time or ordering).

Stability: 0.02% per hour after 1/2 hour warm up.

Temperature Coefficient: 150 ppm per °C.

Temperature:

Operating: 20°C - 50°C.

Storage: -40°C - 80°C.

Monitoring:

0-10VDC corresponding to 0-100% of output voltage.

0-10VDC corresponding to 0-100% of output current.

(Other scale factors available).

Control: Logic level control for high voltage enable/disable.

IMPORTANT

This control signal is not a safety interlock and should not be used for protection from high voltage generation for safety purposes.

1.3 Standard Features:

The PTV series incorporates several standard features designed to optimize user operation.

Slow Start: Provides a gradual increase in high voltage output until the maximum set point is reached. Various slow start times can be accommodated. Consult Spellman's Sales Department for information on slow start options.

Overvoltage Protection: An overvoltage protection circuit monitors the output for excessive voltage generation. Overvoltage conditions can be caused by excessive input program signal or an internal defect in the control circuits. If an overvoltage condition is detected, the power supply is latched off until input power is reset.

Overvoltage Indication: An open collector signal is provided to give the user an indication that an overvoltage condition occurred.

Internal EMI Filter and Fuse Protection: An internal EMI filter and fuse provide protection against line voltage surges and power supply faults.

1.3.1 Remote operating Features:

Remote Programming: Allows remote adjustment of the output voltage and current via an external voltage source

Remote Monitor: Allows remote monitoring of the Output voltage and current.

High Voltage Enable/Disable: Allows remote ON/OFF control of the high voltage.

+10VDC Reference: A +10VDC reference is provided for remote programming via a potentiometer or resistive divider.

1.4 Options:

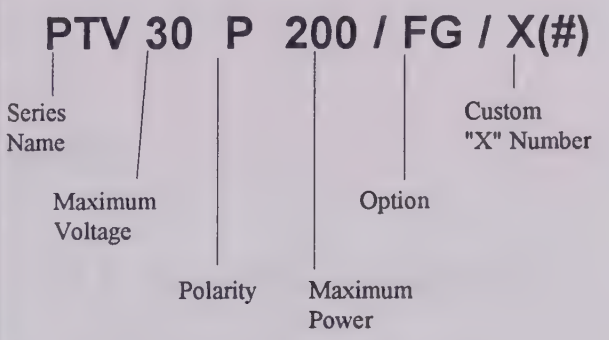
The options available are listed in Table 1.1 See section 5 for more information on the options along with operating and set-up instructions. With few exceptions, these options can be retrofitted to your power supply at the factory in a short time. For price and retrofit arrangements, contact the Spellman Sales Department.

CODE	DESCRIPTION
FG	Floating Ground
220	220VAC Single Phase Input
NSS	No Slow Start
SS(X)	Non-Standard Slow Start
LL(X)	Extra Length Output Cable
¤	Output Connector
¤	Focus Outputs
¤	Grid Outputs

1.5 Interpreting the Model Number:

The model number of the power supply describes its capabilities. After the series name is:

(1) The maximum voltage in kilovolts
(2) The polarity of the output - positive (P), or negative (N).
(3) The maximum output in watts.



(4) The option code for all options that are included.
(5) Custom "X" number representing details listed in a separate specification control drawing.

Chapter 2

Inspection and Installation

Initial inspection and preliminary check-out procedures are recommended. For safe operation, please follow the step-by-step procedures described in Chapter 3, Operating instructions.

2.1 Initial Inspection

Inspect the package exterior for evidence of damage due to handling in transit. Notify the carrier and Spellman immediately if damage is evident. Do not destroy or remove any of the packing material used in damaged shipment. After unpacking, inspect the panel and chassis for visible damage.

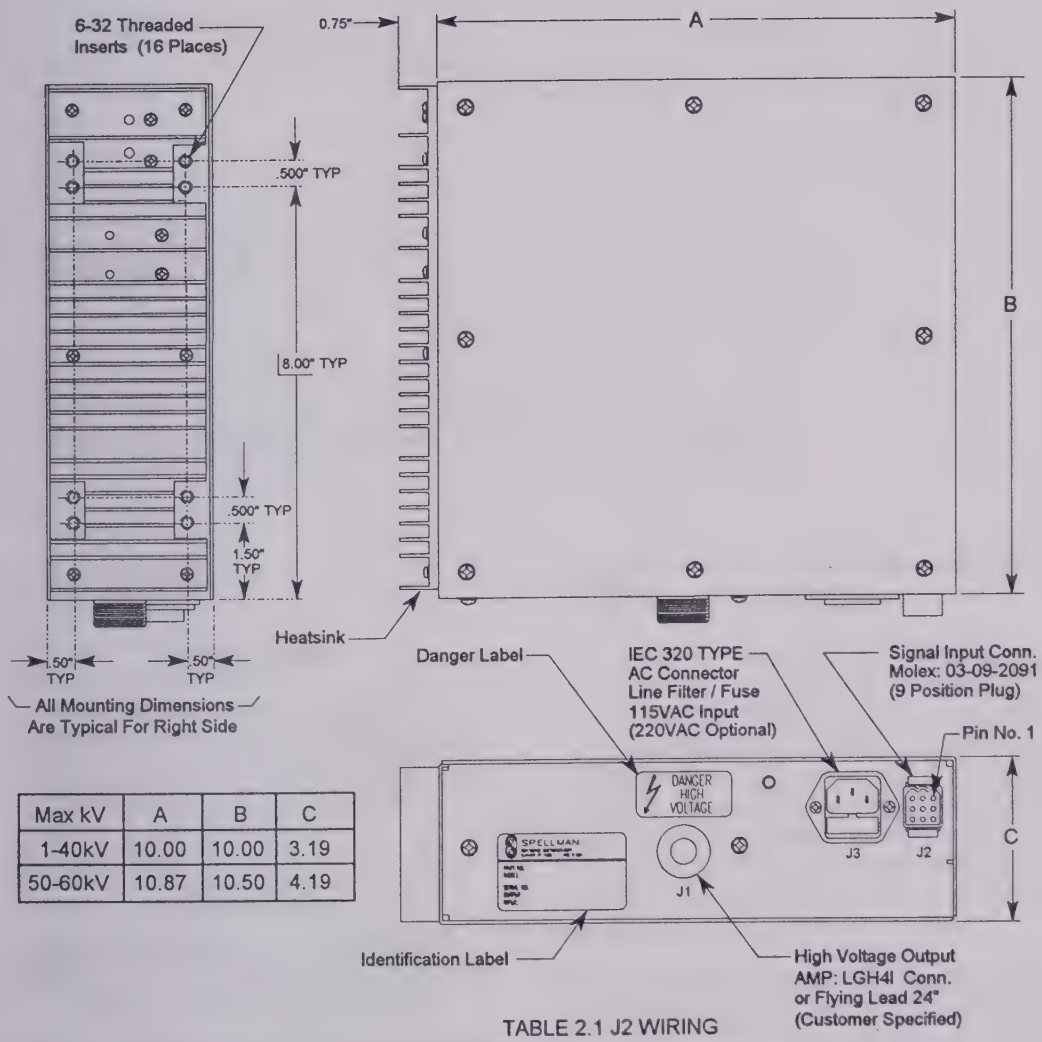
Fill out and mail the Warranty Registration Card accompanying the unit. Standard PTV200 high voltage power supplies and components are covered by warranty. Custom and special order models (with an X suffix in the model number) are also covered by warranty.

2.2 Mechanical Installation

The PTV series of module power supplies are designed for installation into existing or newly developed OEM equipment. The power supply can also easily fit into bench top applications or test set requirements. Standard unit dimensions are shown in Figure 2.1.

For custom mounting requirements or specific package size requirements consult Spellman's Sales Department. Spellman has many package designs available, or can design a specific enclosure for your requirement.

The PTV series utilizes solid encapsulations for corona free operation. No periodic maintenance is required. Lower voltage units (under 6KV) utilizes air insulation. Due to conservative voltage spacing design, periodic maintenance is not required.



Max kV	A	B	C
1-40kV	10.00	10.00	3.19
50-60kV	10.87	10.50	4.19

J2
Pin No.
Orientation

TABLE 2.1 J2 WIRING

J2 Pin No.	FUNCTION
1	+10.35 Volts
2	Current Program
3	Voltage Monitor
4	Voltage Program
5	Common Ground
6	Current Monitor
7	Enable
8	OVP Indicator
9	Control and Monitor RTN

Figure 2-1 Unit Dimensions

Chapter 3

OPERATING INSTRUCTIONS

3.1 Operation

WARNING

THIS EQUIPMENT GENERATES DANGEROUS VOLTAGES THAT MAY BE FATAL. PROPER GROUNDING OF ALL HIGH VOLTAGE EQUIPMENT IS ESSENTIAL.

IMPORTANT

BEFORE CONNECTING THE POWER SUPPLY TO THE AC LINE, FOLLOW THIS STEP BY STEP PROCEDURE.

DO NOT CONNECT THE POWER SUPPLY TO THE AC LINE UNTIL STEP G IS REACHED. FAILURE TO FOLLOW THESE PROCEDURES MAY VOID THE WARRANTY.

A) Insure that the high voltage cable is properly terminated to the load. Insure that all circuits connected to the high voltage output are safety interlocked against accidental contact. Insure external load is discharged.

B) Check the input voltage rating on the serial nameplate of the supply and make certain that this is the rating of the available power source. PTV modules operate on 115VAC unless ordered with a different input voltage option.

C) Proper Grounding Technique: The chassis of high voltage power supplies must be grounded, preferably to a water system ground or other earth ground. See Figure 3.1 for a typical operating set up. The return line from the load should be connected to the power supply chassis. Using a separate external ground at the load is not recommended. An IEC 320 connector is provided for connection to the line voltage source. A standard three prong line cord is also provided.

D) Options Note: See Section 5 for hook up and operating instructions for the options on your unit. Custom models may also require set-up changes.

E) Hook-up: Connect control and monitoring connections as described in this manual.

F) For initial turn on, program the voltage and current for zero output. Connect the enable/disable signal to disable.

G) The input cable may now be connected to the AC power line.

H) Enable the power supply via the enable/disable logic signal.

I) Slowly program the output voltage and current to desired level. Monitor the output voltage and current via the monitoring test points. Note equipment operation is nominal, i.e. Load is behaving as predicted.

J) To turn high voltage off, use the enable/disable signal. If equipment is to be kept off for extended periods, disconnect power supply from line voltage source.

NOTE: If an over voltage condition occurs, the power supply will latch off. To reset the power supply, remove the line voltage and reconnect.

WARNING

After turn off, do not handle the load until the capacitance has been discharged! load capacitance may be discharged by shorting to ground.

WARNING

The voltage monitor on the power supply does not read the output voltage when the line voltage is disconnected, even if a charge still exists on the load.

CAUTION

Always operate the unit with the cover on. Do not attempt to access or repair any internal circuits. Dangerous and lethal voltages are generated inside the module.

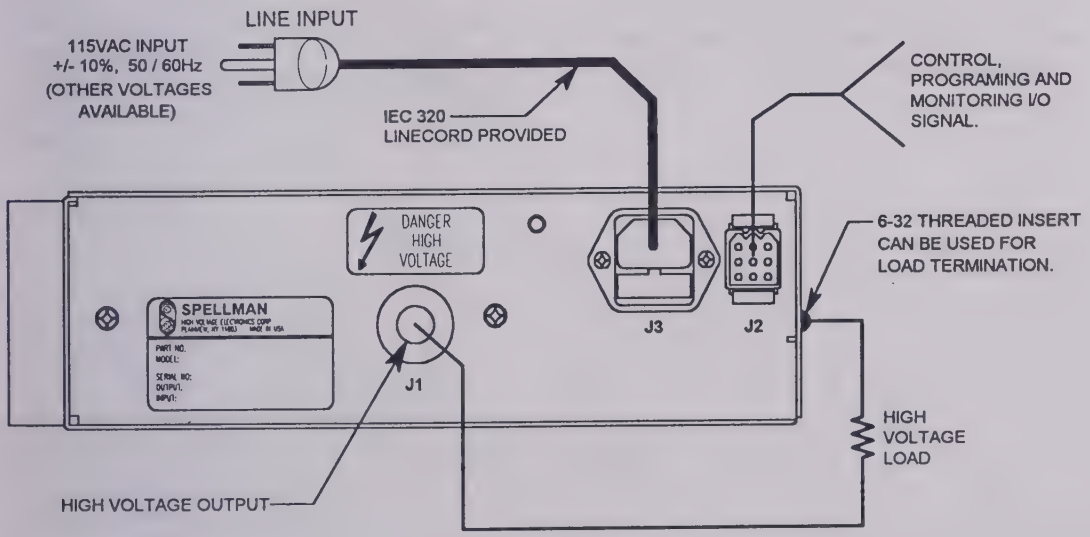


Figure 3.1 Typical Operating Set Up

3.2 Standard Features:

A note on remote interface circuitry and remote signal grounding: whenever possible, electrical isolation should be provided when interfacing with any high voltage power supply. For enable/disable signal connections, an isolated relay or optocoupler should be used. For OVP indication a LED or optocoupler should be used. If possible, analog programming and monitoring signals should be isolated via analog isolation amplifiers. Spellman application engineers are available to assist in interface circuitry design. All interface cables should be properly shielded. All power supply signals should be referenced to the power supply signal ground or power supply chassis ground.

Remote Programming: Allows remote adjustment of the output voltage and current via an external voltage source. 0-10VDC signal is supplied to Pin 4 of the control input connector for voltage programming and 0-10VDC signal is supplied to Pin 2 of the control input connector for current programming. Programming signals should be referenced to Pin 9 of the control input connector signal ground. By adjusting the voltage source from 0 volt (zero output) to 10 volts (full rated output) the desired output can be selected. See Figure 3-2A for wiring diagram and specifications.

An alternate method of controlling the output remotely is by using external resistance such as a potentiometer or a resistor network. See Figure 3.2B for wiring diagram.

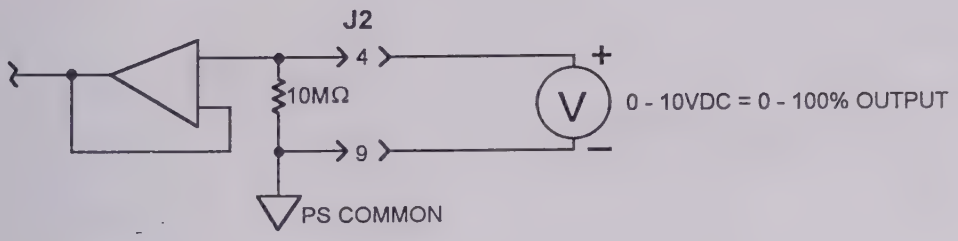
Remote Monitoring: Test points are made available for monitoring the voltage and current output. The test points are always positive regardless of the output polarity where zero (0) to ten (10) volts equals 0-100% of output. See Figure 3.3 for test point wiring.

Enable/Disable Control: Remote control of the high voltage on and high voltage off can be done via the enable/disable logic control. See Figure 3.4 for recommended interface circuits.

WARNING

It is extremely dangerous to use this circuit to inhibit high voltage generation for the purpose of servicing or approaching any area or load considered unsafe during normal use.

OVP Indicator/Power Supply On Indicator: A logic signal is provided which can be used to determine if the OVP Shutdown Circuit is active, and/or if the power supply is ON. See figure 3.5.



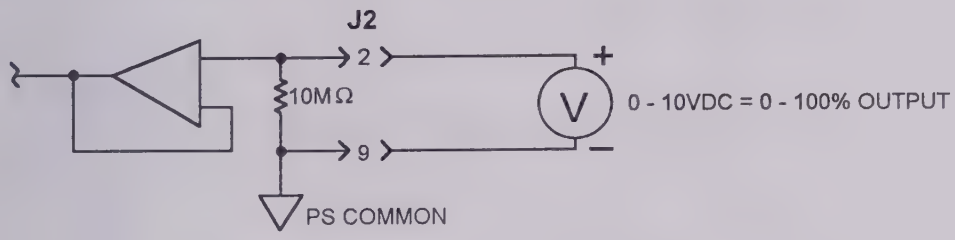
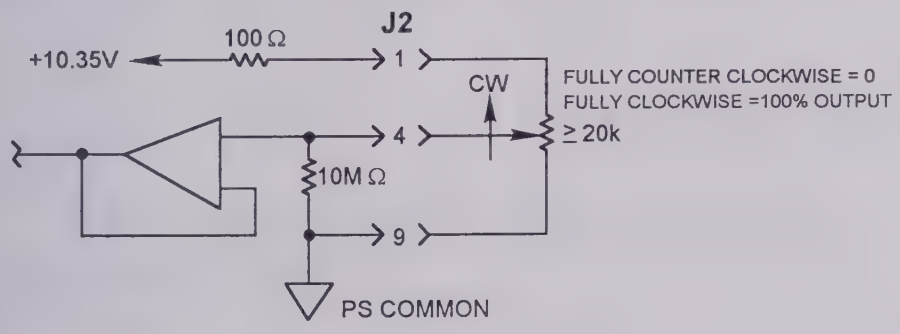


Figure 3.2A Remote Programming Via Voltage Source



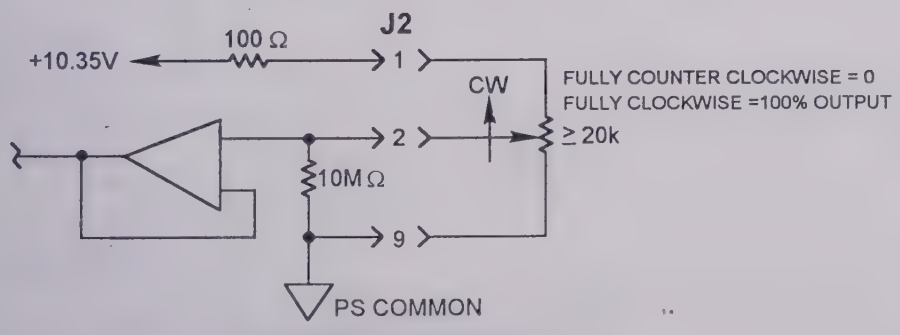


Figure 3.2B Remote Programming Via External Resistance

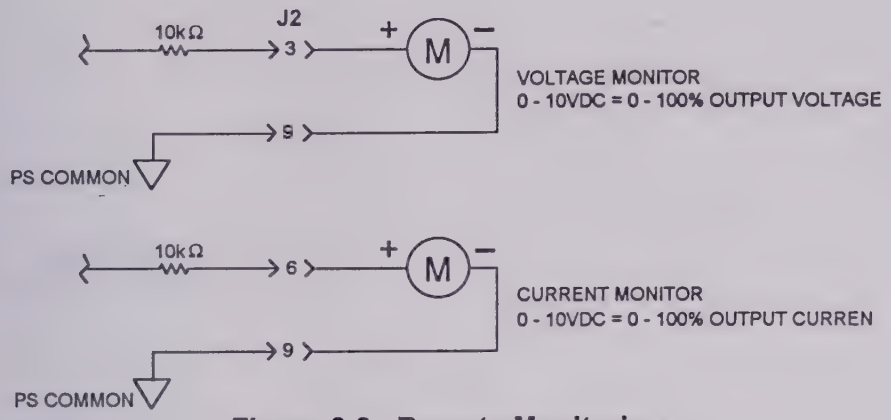
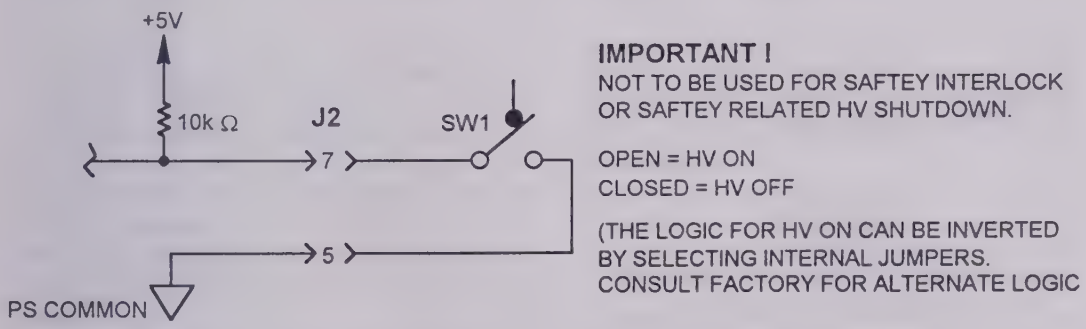
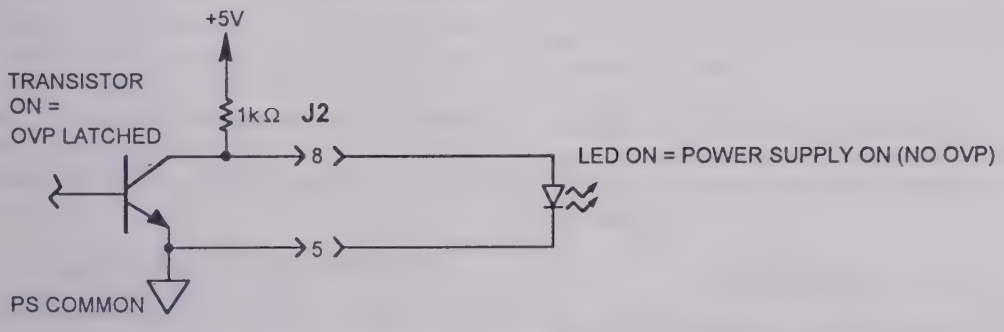


Figure 3.3 Remote Monitoring



NOTE: SW1 CAN BE A SWITCH, RELAY, OR OPEN COLLECTOR DEVICE
SUCH AS THE TRANSISTOR OUTPUT OF AN OPTOCOUPLER.

Figure 3.4 HV ON/OFF Control



NOTE: NOT TO BE USED FOR SAFTEY INDICATION FOR THE PRESENCE
(OR LACK THERE OF) OF HIGH VOLTAGE

Figure 3.5 OVP / Power Supply On Indicator

CHAPTER 4

PRINCIPLES OF OPERATION

The PTV series of high voltage power supplies utilize sophisticated power conversion technology. Advanced analog and power conversion techniques are used in the PTV series. The intention of the Principles of Operation is to introduce the basic function blocks of the PTV power supply. For details on a specific circuit consult Spellman's Engineering Department.

The PTV power supply is basically an AC to DC power converter. Within the power supply, conversions of AC to DC, then to high frequency AC, then to high voltage DC take place.

Typical PTV power supplies comprise a few basic building blocks. These are: 1) AC to DC rectifier, 2) High frequency quasi-resonant inverter, 3) High voltage transformer and rectifier circuits, and 4) Control and monitoring circuits. The following is a brief description of each building block.

4.1 AC to DC Rectifier and Associated Circuits

The PTV series can operate from 115VAC +/-10% or 220VAC +/-10%. (Alternate input voltage ranges can be accommodated. Consult Spellman's Sales Department for details).

The input voltage is connected via a typical IEC 320 type input connector. An internal EMI filter and fuse housing is an integral part of the IEC input module.

WARNING

To reduce the risk of fire, replace fuse with same type and rating.

The input line voltage is applied to a current limit device to reduce the initial inrush current. The input line voltage is converted to a 300VDC voltage via a bridge rectifier/capacitor filter circuit.

On newer PTV modules a 300VDC indicator neon lamp is provided inside the unit to indicate the presence of voltage.

The input AC line voltage is also connected to a step-down transformer which is used to generate +/-24VDC, +/-15VDC, and 10VDC via low voltage regulators.

WARNING

The energy levels used and generated by the power supply can be lethal! Do not attempt to operate the power supply unless the user has a sufficient knowledge of the danger and hazards of

working with high voltage. Do not attempt to approach or touch any internal circuits or components that are connected or have been connected to the power supply. Be certain to discharge any stored energy that may be present before and after the power supply is used. Consult IEEE recommended practices for safety in high voltage testing #510-1983.

4.2 High Frequency Inverter

The PTV is a resonant converter operating in a zero current switching, series resonant, parallel loaded topology. MOSFET transistors switch the 300VDC voltage to the resonant tank circuit. Typical operating frequency is in the range of 35-65KHz depending on model. Control of the resonant circuit output is done by the low voltage control circuits, and are isolated by an isolated pulse transformer. The output of the resonant circuit is applied to the primary of the high voltage transformer.

4.3 High Voltage Circuits

The high voltage transformer is a step-up type. The secondary of the high voltage transformer is connected to the high voltage rectifier circuit. The rectifier circuit will vary depending upon the rated output voltage. For lower output voltage, a full bridge or doubler circuit is used. For higher voltages, a half wave Cockroft-Walton multiplier is used. A feedback signal is generated by the high voltage resistor divider. This feedback signal is sent to control circuits to provide voltage regulation and monitoring. A current sense resistor is connected at the low voltage end of the rectifier circuit. The current sense signal is sent to the control circuits to provide current regulation and monitoring.

An auxiliary voltage sense signal is generated by the overvoltage protection feedback resistor. This is used to provide overvoltage protection.

The high voltage rectifier output is connected to an R-C type filter to reduce high frequency ripple components. The filter is then connected to the output limiting resistors. These resistors limit the peak surge current in the event an arc or discharge occurs. The limiting resistor output is connected to the output cable or connector provided.

4.4 Control Circuits

Control circuits are used for regulation, monitoring, pulse-width control, slow-start and inhibit control. Feedback signals are calibrated and buffered via general purpose OP-AMPS. Pulse width control is accomplished by a typical PWM type control I.C. Logic enable/disable is provided by a logic gate I.C. As stated previously, regulators generate +/-15V and 10VDC.

WARNING

Line voltage is present whenever the power supply is connected to external line voltage. Be sure to disconnect the line cord before opening the unit. Allow 5 minutes for internal capacitance to discharge before removing any cover.

4.5 Options

Due to the many variations of models and options provided in the PTV series, details of actual circuits used may differ slightly from above descriptions. Consult Spellman's Engineering Department for questions regarding the principles of operations for the PTV series.

Chapter 5

OPTIONS

The options available for this power supply are described in this section. Interface diagrams are shown where required. Options are specified by including the option code in the model number as described in Section 1.4.

5.1 FLOATING GROUND FG

The floating ground option allows isolation of the power supply common from chassis ground. A typical application for FG is for connection of an external meter or circuit into the FG signal point. This circuit can monitor actual current flow at a low voltage level. See Figure 5.1 for typical connection to the floating ground terminal.

IMPORTANT

The power supply common must be connected to chassis ground through a low impedance circuit. The power supply common is clamped to chassis ground using a power zener diode. This diode is not intended to clamp under continuous operation. On higher current units the power dissipation within the zener diode can be excessive if allowed to clamp.

5.2 220V AC SINGLE PHASE INPUT 220

PTV power supplies with the 220 V AC input option will operate from an input voltage of 220V AC rms ±10%, 50-60Hz, single phase.

5.3 NO SLOW START NSS

The no slow start option causes the output voltage of the power supply to rise (within 50 msec) to the rated voltage upon Power Up.

5.4 NON-STANDARD SLOW START SS(x)

The non-standard slow start option allows the gradual rise time of the output voltage to be different from the standard of six seconds. To order the option place the time desired in seconds after the suffix letter; i.e. SS(10) denotes a 10 second rise time.

5.5 EXTRA LENGTH OUTPUT CABLE LL(ft)

Standard output cable is 18" long. Other lengths may be specified.

5.6 Focus Outputs

Focus outputs for CRT type applications can be provided. Generally, the focus output range is 6kV - 12kV, <1mA. Specific focus output requirements should be discussed with Spellman's sales department. Multiple focus, dynamic focus and variable focus control can also be provided.

5.7 Grid Outputs.

Grid outputs for CRT type applications can be provided. Grid outputs can either be fixed or adjustable. Generally, grid outputs are in the ranges of a few hundred volts to 1800V, ≤ 1mA. Specific grid output requirements should be discussed with Spellman's sales department.

5.8 CUSTOM DESIGNED MODELS X(#)

Units built to customer specifications are assigned an X number by the factory. If this unit is an X model, a specification control sheet is added at the end of this instruction manual.

Spellman welcomes the opportunity to tailor units to fit your requirements or to develop new products for your applications. Contact the Spellman Sales Department with your needs.

NOTE: Before operating this system, refer to operating instructions in Chapter 3.

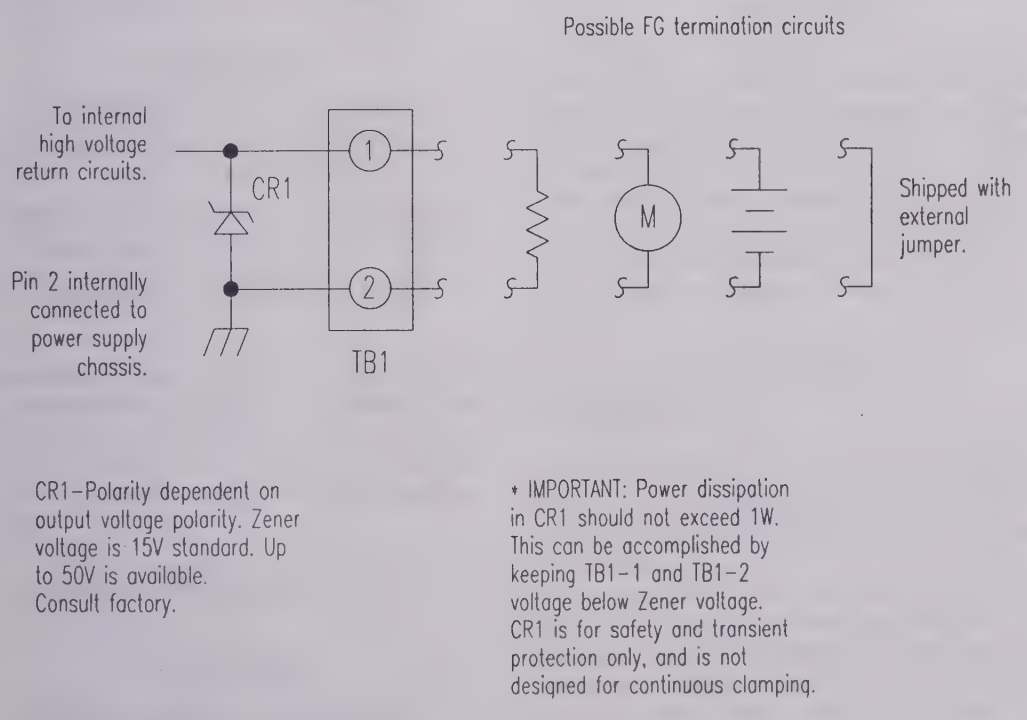

Possible FG termination circuits
To internal high voltage return circuits.
CR1
1
2
TB1
Pin 2 internally connected to power supply chassis.
M
Shipped with external jumper.
CR1-Polarity dependent on output voltage polarity. Zener voltage is 15V standard. Up to 50V is available. Consult factory.
* IMPORTANT: Power dissipation in CR1 should not exceed 1W. This can be accomplished by keeping TB1-1 and TB1-2 voltage below Zener voltage. CR1 is for safety and transient protection only, and is not designed for continuous clamping.

Figure 5.1 - Floating Ground Interface Circuit

Chapter 6

MAINTENANCE

This section describes periodic servicing and performance testing procedures.

WARNING

THIS POWER SUPPLY GENERATES VOLTAGES THAT ARE DANGEROUS AND MAY BE FATAL.

OBSERVE EXTREME CAUTION WHEN WORKING WITH HIGH VOLTAGE

6.1 PERIODIC SERVICING

Approximately once a year (more often in high dust environments), disconnect the power to the unit and remove the top cover. Use compressed air to blow dust out of the inside of the unit. Avoid touching or handling the high voltage assembly.

6.2 PERFORMANCE TEST

WARNING

HIGH VOLTAGE IS DANGEROUS.

Only qualified personnel should perform these tests.

High voltage test procedures are described in Spellman Bulletin STP-783, Standard Test Procedures for High Voltage Power Supplies. Copies can be obtained from the Spellman Customer Service Department. Test equipment, including an oscilloscope, a high impedance voltmeter, and a high voltage divider such as the Spellman HVD-100 or HVD-200, is needed for performance tests. All test components must be rated for operating voltage.

6.3 HIGH VOLTAGE DIVIDERS

High voltage dividers for precise measurement of output voltage with an accuracy up to 0.1% are available from Spellman. The HVD-100 is used for voltages up to 100KV. The HVD-200 measures up to 200KV. The Spellman divider is designed for use with differential voltmeters or high impedance digital voltmeters. The high input impedance is ideal for measuring high voltage low current sources, which would be overloaded by traditional lower impedance dividers.

Chapter 7

REPLACEMENTS PARTS

7.1 Replacement Parts

Spellman provides parts and subassemblies for its high voltage power supplies but recommends that only qualified personel perform the repair. High voltage is dangerous; even minor mistakes in repairs can have serious consequences.

When requesting parts please give the model number and serial number of the power supply. See Recommended Spare Parts PTV200 on page 7-2 for a list of standard replacement parts.

7.2 CORRESPONDENCE AND ORDERING AND ORDERING SPARE PARTS

Each Spellman power supply has an identification label on the rear of the chassis that bears its model and serial number.

When requesting engineering or applications information, please state the model and serial number of the power supply. If specific circuit sections are involved in the inquiry, it is helpful to indicate the component symbol number(s) shown on the applicable block diagram.

When ordering spare parts, please specify the part's description, the part's reference designation or part number, and the model and serial number of the unit. Example: Two Transistors, Mosfet IRFP450F1 for Model PTV40P200 Power Supply, serial # C01225.

7.3 RECOMMENDED SPARE PARTS PTV200

DESCRIPTION	PART NUMBER	QTY
Fuse. 4A. 250V Slow Blow	105721-045	1
Diode, SB140	105402-044	2
Diode Bridge KBU65	105404-031	1
Diode Bridge, EDF1AM	105404-025	1
Diode, 1N4744	105403-060	2
Transistor, 2N4401	105405-087	1
IC, CD4093BCN	105407-061	1
IC, LF444ACN	105407-163	3
IC, SG3525AN	105407-097	1
IC, TLO82CP	105407-027	1
Voltage Regulator, LM340-15	105411-012	1
Voltage Regulator, MC791SCT	105411-009	1
Diode, Rect., MUR440	105401-043	4
Capacitor, Film, 0.47MF 600V	105207-123	3
Fuse, 2.5A Fast Acting	105721-056	1
Transistor, Mosfet IRFP 450F1	105407-184	1
Diode, 1N4743A	105403-054	1
IC, REF0ICF	105407-160	1

Chapter 8

FACTORY SERVICE

8.1 WARRANTY REPAIRS

During the Warranty period, Spellman will repair all units free of charge. The Warranty is void if the unit is worked on by other than Spellman personnel. See the Warranty in the rear of this manual for more information. Follow the return procedure described in Section 8.2. Customer shall pay shipping to and from Spellman.

8.2 FACTORY SERVICE PROCEDURES

Spellman has a well-equipped factory repair department. If a unit is returned to the factory for calibration or repair, a detailed description of the specific problem should be attached.

For all units returned for repair, please obtain an authorization to ship from the Customer Service Department either by phone or mail prior to shipping. When you call, please state the model and serial numbers which are on the plate on rear of the power supply and the purchase order number for the repair. A Return Material Authorization Code Number (RMA number) is needed from Spellman for all returns. This RMA number should be marked clearly on the outside of the shipping container. Packages received without an RMA Number will be returned to the customer. Customer shall pay shipping to and from Spellman.

A preliminary estimate for repairs will be given by phone by Customer Service. A purchase order for this amount is requested upon issuance of the RMA Number. A more detailed estimate will be made when the power supply is received at the Spellman Repair Center. In the event that repair work is extensive, Spellman will call to seek additional authorization from your company before completing the repairs.

8.3 ORDERING OPTIONS AND MODIFICATIONS

Many of the options listed in Chapter 5 can be retrofitted into Spellman power supplies by our factory. For prices and arrangements, contact our Sales Department.

8.4 SHIPPING INSTRUCTIONS

All power supplies returned to Spellman must be sent shipping prepaid. Pack the units carefully and securely in a suitable container, preferably in the original container, if available. The power supply should be surrounded by at least four inches of

shock absorbing material. Please return all associated materials, i.e. high voltage output cables, interconnection cables, etc., so that we can examine and test the entire system.

All correspondence and phone calls should be directed to:

Spellman High Voltage Electronics Corporation
475 Wireless Boulevard
Hauppauge, NY 11788

(631) 630-3000 * FAX: (631) 435-1620
E-Mail: sales@spellmanhv.com
http://www.spellmanhv.com

WARRANTY

The Spellman High Voltage Electronics Corporation (hereinafter referred to as "Spellman") warrants all power supplies it manufactures to be free from defect in materials and factory workmanship, and agrees to repair or replace any power supply that under normal use reveals a defect due to faulty manufacturing during the Warranty period.

This Warranty shall not apply to any power supply that has been:

i. repaired, worked on, or altered by persons unauthorized by Spellman in such a manner as to injure, in Spellman's sole judgment, the performance, stability, or reliability of the power supply;

ii. subjected to misuse, negligence, or accident; or

iii. connected, installed, adjusted, or used otherwise than in accordance with the instructions furnished by Spellman.

This warranty is in lieu of any other warranty, express or implied, including the warranty of merchantability and fitness for a particular purpose.

Spellman reserves the right to make any changes in the design or construction of its power supplies at any time, without incurring any obligation to make any change whatever in units previously delivered.

Spellman's sole liabilities, and the buyer's sole remedies, under this agreement, shall be limited to a refund of the purchase price, or, at Spellman's sole discretion, to the repair or replacement of any power supply that proves, upon Spellman's examination, to be defective when returned to the Spellman factory within the Warranty period. Customer shall pay shipping charges to and from Spellman.

Spellman shall in no way be liable for damages consequential or incidental to defects in any power supply, for failure of delivery in whole or in part, for injuries resulting from its use, or for any other cause.

This Warranty and the writing attached constitute the full understanding of the manufacturer and the buyer, and no terms, conditions, understanding, or agreement purporting to modify or vary the terms hereof shall be binding unless hereafter made in writing and signed by an authorized officer of the Spellman High Voltage Electronics Corporation.

Standard **PTV** Power Supplies are covered by a one-year warranty. Consult factory for warranty information of special order models.

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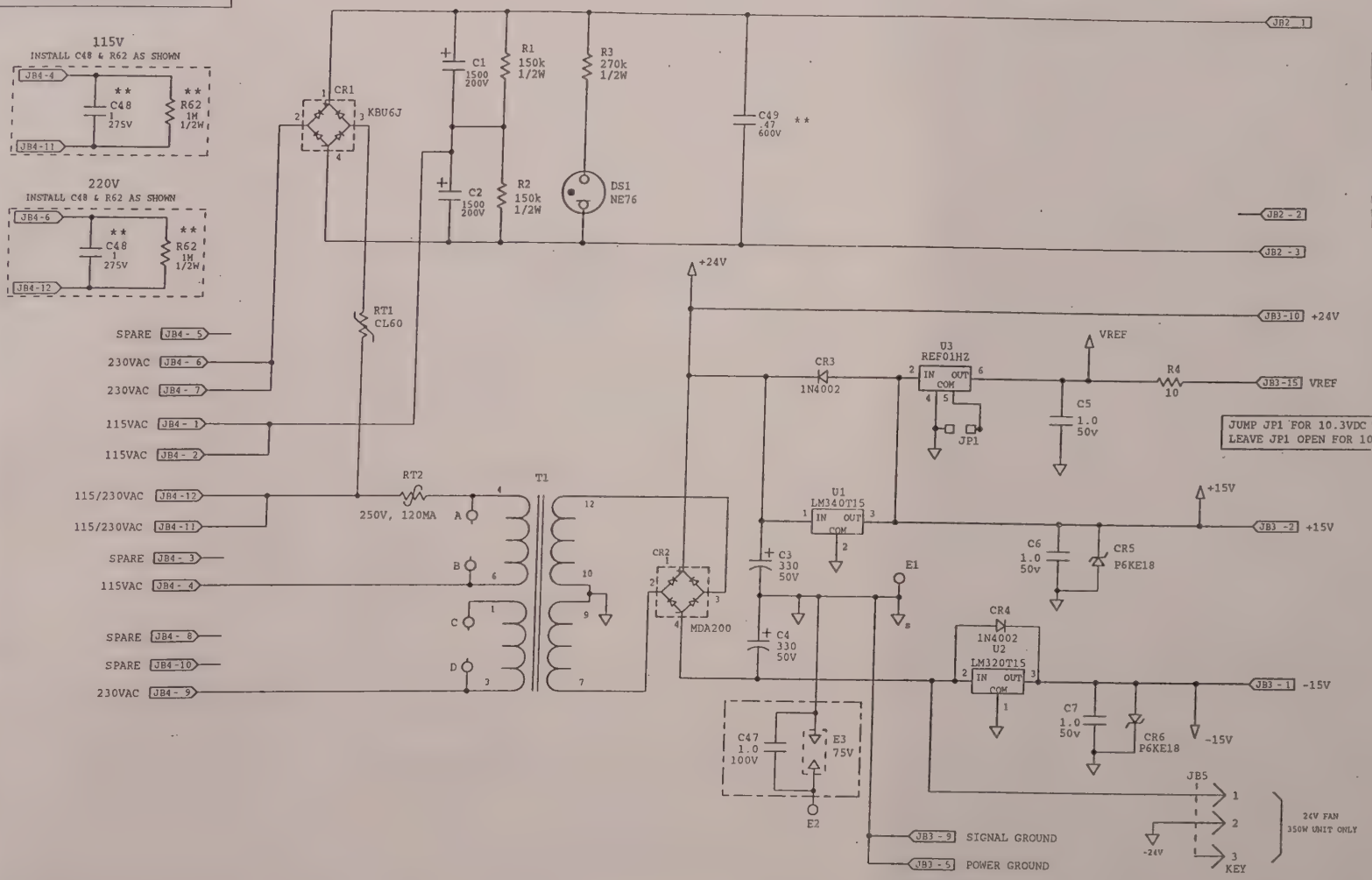


REVISIONS			APPROVED		
LTR	DESCRIPTION	DATE	ENGR DEPT	PROJ DEPT	QUALITY
B	RELEASED PER ECR 3331	9/30/93	N/A	M.T.	K.K.
B1	REVISED PER ECN 7508	11/29/93	N/A	M.T.	KK TS
B2	REVISED PER ECN 7680, BOM UPDATE	12/27/93	N/A	M.T.	KK TS
B3	REVISED PER ECN 8175	8/12/94	N/A	C.M.S.	KK TS
C	REVISED PER ECN 8392 - ADDED -005	11/23/94	N/A	R.D.	KK TS
C1	REVISED PER ECN 8549 ADDED -006	3/24/95	N/A	R.D.	KK TS
C2	REVISED PER ECN 9197 - ADDED -010 THUR -040 -110 THRU -140,-310 THRU -340,-410 THRU -440	11/10/95	N/A	JP	KK,TS
C3	REVISED PER ECN 10242	2/14/97	N/A	MT	KK,TS
C4	REVISED PER ECN 10352	6/6/97	N/A	MT,PS	KK,LB
C5	REVISED PER ECN 10712	8/6/97	MH	MT	KK,LB
C6	REVISED PER ECN 10963	11/26/97	MV	PS	KK,LB
C7	REVISED PER ECN 11145	12/30/97	AP	MT	KK,LB
C8	REVISED PER ECN 11426	4/7/98	N/A	MT	KK,LB
C9	REVISED PER ECN 11808	9/15/98	N/A	MT	KK/LB
C10	REVISED PER ECN 12347	3/29/99	N/A	MT	KK/LB
C11	REVISED PER ECN 12602	9/28/99	MH	MT	KK/EC
C12	REVISED PER ECN 12608	11/4/99	N/A	MV	KK/EC
C13	REVISED PER ECN 12818	12/3/99	N/A	MV	KK/EC
C14	REVISED PER ECN 12867	12/09/99		MT	KK/EC

NOTES
1. UNLESS OTHERWISE SPECIFIED:
   RESISTORS ARE IN OHMS, 1/4W.
   1/8W RESISTORS ARE RN, 1%.
   1/10W RESISTORS ARE RN, 0.1%.
   CAPACITORS ARE IN MICROFARADS.
   ALL DIODES ARE PDH333.
2. ALL CAPACITORS WITH UNMARKED VOLTAGES ARE 50 VOLT MIN.
3. * INDICATES TABULATED COMPONENTS SEE TABLE 1 AND TABLE 2, SHEET 4.
4. COMPONENTS SHOWN IN [ ] ARE OPTIONAL. SEE TABLE 1, SHEET 4.
5. ** INDICATES COMPONENTS FOR CE FEATURE.

FOR 115VAC INPUT: CONNECT INPUT TO JB4-1 AND JB4-12
JUMP JB4-2 TO JB4-4, JUMP T1-A TO T1-C,
JUMP T1-B TO T1-D
FOR 230VAC INPUT: CONNECT INPUT TO JB4-6 AND JB4-12
JUMP JB4-7 TO JB4-9, JUMP T1-B TO T1-C
FOR 115VAC/230VAC: SELECTABLE: JUMP T1-B TO T1-C.

440548-023	403986-005	PTV23P100 X2131
440548-103 THRU 440548-108	403986-005	PTV1-5KV N200/350W
440548-003 THRU 440548-008	403986-005	PTV1-5KV P200/350W
440548-004	403986-001	PTV60W200/(115/220)
440548-007	403986-001	PTV40W200/(115/220)
	SEE TABLE 2	

APPROVALS

	BY	DATE
DRAWN	JOE S	7/9/93
CHECKED	N/A	N/A
DESIGN	MH	1/30/93
ENGR DEPT	N/A	N/A
PROJ DEPT	M.T.	9/30/93
Q.A.	K.K.	10/1/93
MFG. ENG	TS	10/1/93

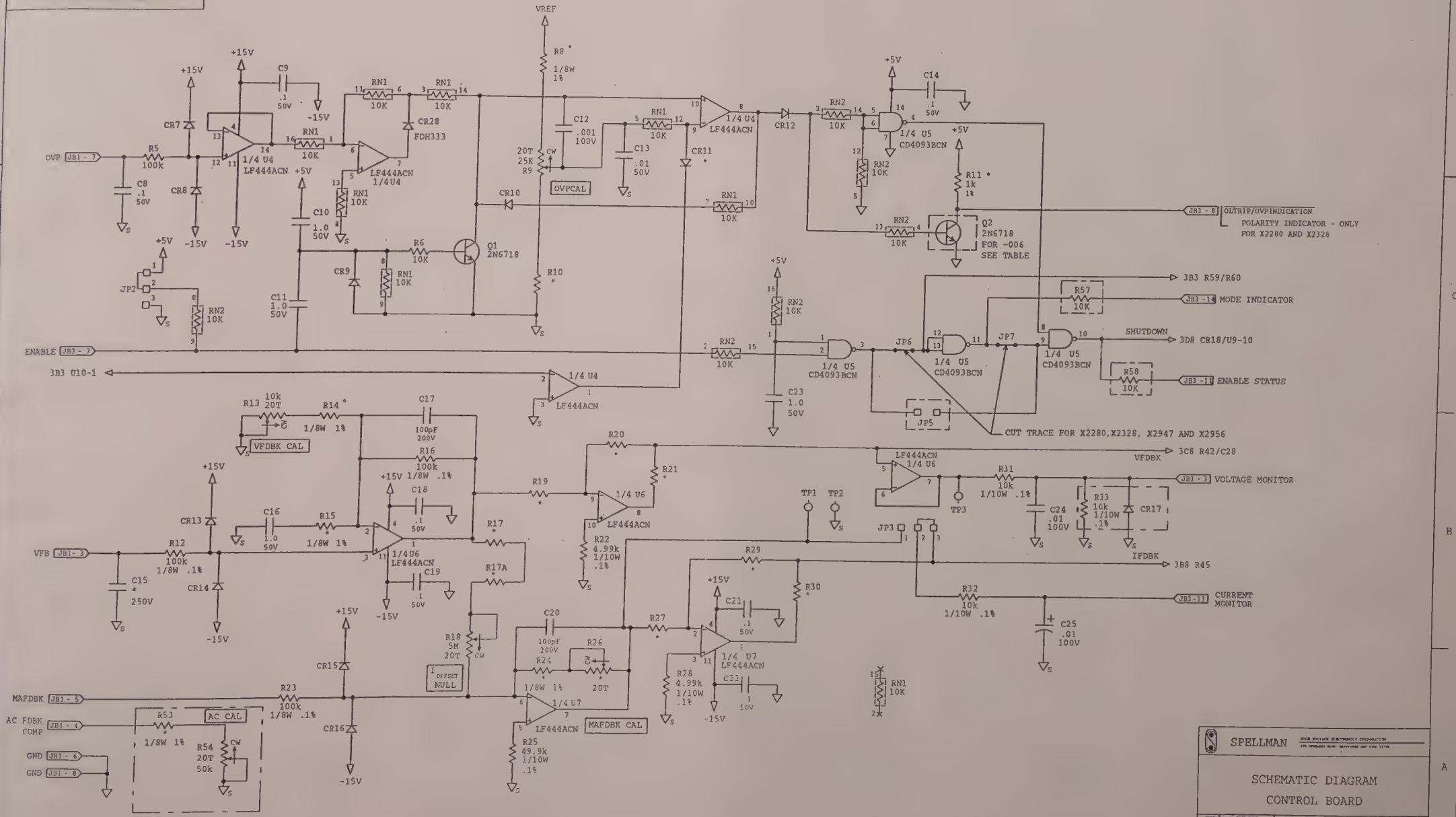
SPELLMAN

SCHEMATIC DIAGRAM
CONTROL BOARD

SIZE	CAGE CODE	DRAWING NO.	REV
D	10610	440548-TAB	C14

SCALE: NONE | FILE: 440548TC14.SCH | SHEET 1 OF 5

THIS INFORMATION CONTAINED HEREIN IS PROPRIETARY TO SPELLMAN HIGH VOLTAGE ELECTRONICS CORP. AND IS TO BE USED ONLY FOR THE PURPOSES INTENDED AND IS NOT TO BE REPRODUCED EITHER IN WHOLE OR PART WITHOUT THE EXPRESS WRITTEN PERMISSION OF SPELLMAN HIGH VOLTAGE ELECTRONICS CORP.



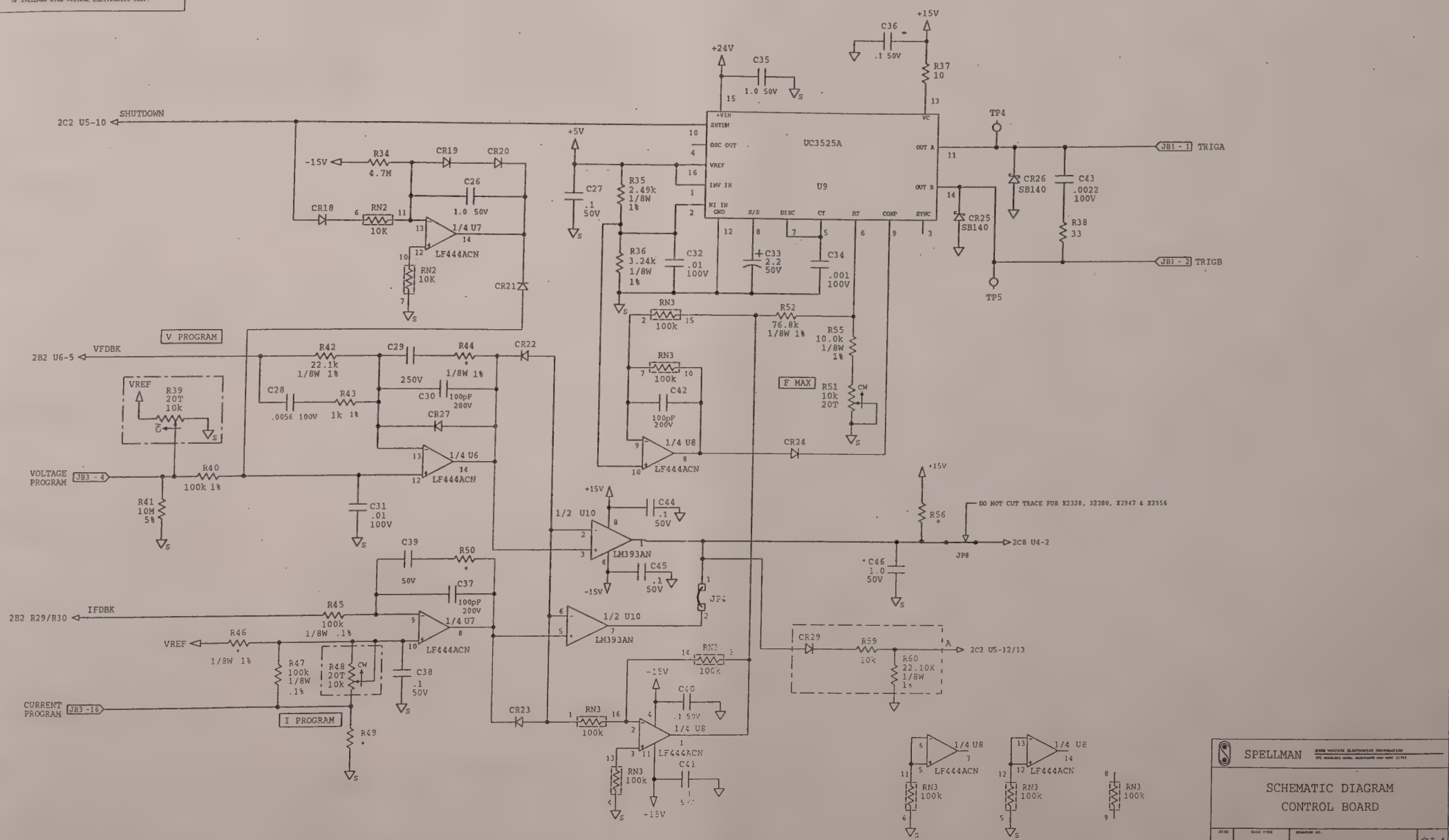
SPELLMAN HIGH VOLTAGE ELECTRONICS CORPORATION

SCHEMATIC DIAGRAM
CONTROL BOARD

SIZE	CAGE CODE	DRAWING NO.	REV
D	10610	440548-TAB	C14

SCALE: NONE | FILE: 440\548TC142.SCH | SHEET 1 OF 5

THIS INFORMATION CONTAINED HEREIN IS PROPRIETARY TO SPELLMAN HIGH VOLTAGE ELECTRONICS CORP. AND IS TO BE USED ONLY FOR THE PURPOSES INTENDED AND IS NOT TO BE REPRODUCED EITHER IN WHOLE OR PART WITHOUT THE EXPRESS WRITTEN PERMISSION OF SPELLMAN HIGH VOLTAGE ELECTRONICS CORP.



SPELLMAN

SCHEMATIC DIAGRAM
CONTROL BOARD

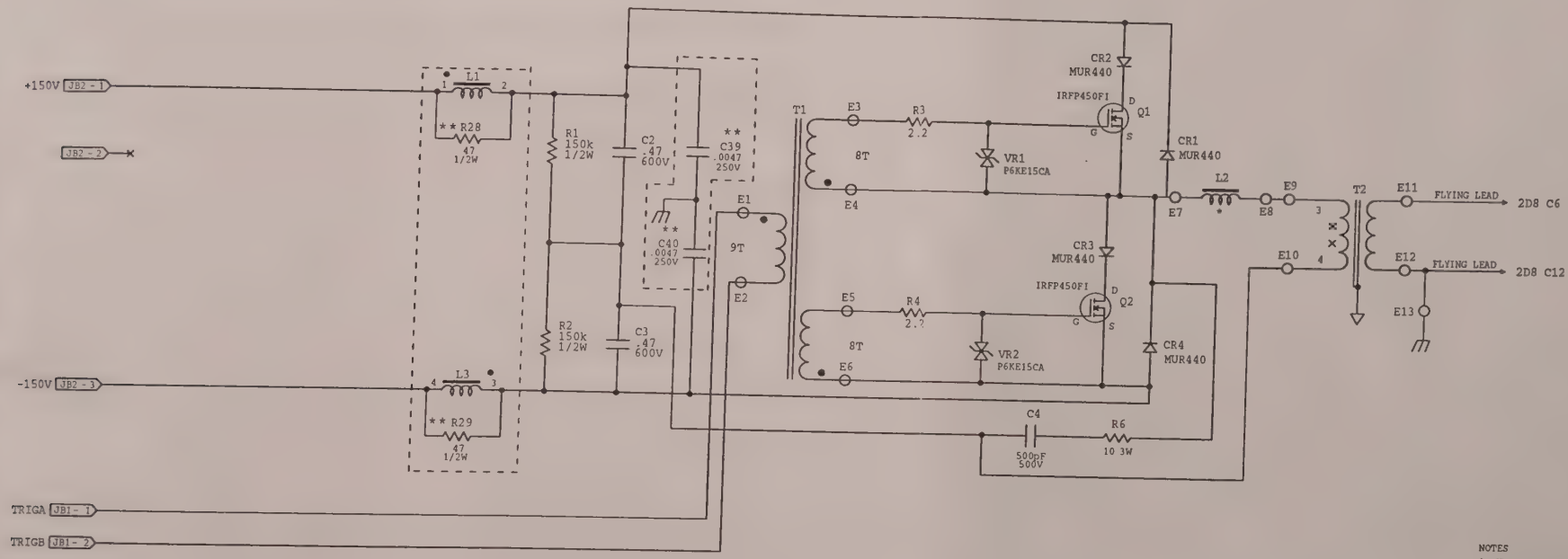
SIZE	CAGE CODE	DRAWING NO.	REV
D	10610	440548-TAB	C14
SCALE: NONE	FILE: 440548TC143.SCH	SHEET 3 OF 5	

THIS INFORMATION CONTAINED HEREIN IS PROPRIETARY TO SPELLMAN HIGH VOLTAGE ELECTRONICS CORP. AND IS TO BE USED ONLY FOR THE PURPOSES INTENDED AND IS NOT TO BE REPRODUCED EITHER IN WHOLE OR PART WITHOUT THE EXPRESS WRITTEN PERMISSION OF SPELLMAN HIGH VOLTAGE ELECTRONICS CORP.

REVISIONS			APPROVED		
LTR	DESCRIPTION	DATE	MFGR ENG	PROJ ENG	QUALITY
A	RELBASED PER EDR 3331	9/30/93	N/A	MT	KK,TS
A1	REVISED PER ECN 9197, ADD -010 THRU -440	11/10/95	MH	JP	KK,TS
B	UPDATED REV TO AGREE WITH ARTWORK, PER ECN 9360	1/5/95	AP	MT	MP,TS
C	UPDATED REV TO AGREE WITH ARTWORK, PER ECN 9760	10/17/96	MH	MT	MP,TS
C1	REVISED PER ECN 10059	11/22/96	MH	MT	MP,TS
C2	REVISED PER ECN 10352	6/6/97	N/A	MT	KK,LB
C3	REVISED PER ECN 10941	10/15/97	N/A	MT	KK,LB
C4	REVISED PER ECN 10984	11/14/97	N/A	MV	KK,LB
D	REVISED PER ECN 10886	1/14/98	AP	MV	KK,LB
D1	REVISED PER ECN 11419	4/17/98	N/A	MV	KK,LB
D2	REVISED PER ECN 12867	12/09/99		GO	

TABLE 1

REF DESG	CE UNIT	200W UNITS	350W UNITS
L1	600 uH	100uH	23uH
L3	P/O L1	100uH	23uH



NOTES

1. UNLESS OTHERWISE SPECIFIED:
   RESISTORS ARE IN OHMS, 1/4W.
   1/8W RESISTORS ARE RN, 1%.
   1/10W RESISTORS ARE RN, 0.1%.
   CAPACITORS ARE IN MICROFARADS.
2. ALL CAPACITORS WITH UNMARKED VOLTAGES ARE 50 VOLT MIN.
3. FOR UNITS WITH NEGATIVE OUTPUT VOLTAGE REVERSE THE POLARITY OF DIODES CR10 - CR19.
4. * INDICATES TABULATED COMPONENTS, SEE TABLE I ON SHEET 9.
5. ** INDICATES COMPONENTS FOR CE FEATURE.

PART NO	NEXT ASSY	USED ON
440549-410 THRU 440549-440	403972-410 THRU 403972-440	403986-005
440549-310 THRU 440549-340	403972-310 THRU 403972-340	403986-005
440549-110 THRU 440549-140	403972-110 THRU 403972-140	403986-005
440549-010 THRU 440549-040	403972-010 THRU 403972-040	403986-005
440549-002	403972-002	403986-004
440549-001	403972-001	403986-003
440549-002	403972-002	X2113
440549-001	403972-001	X2112

APPLICATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: FRACTIONS DECIMALS ANGLES .XX ± .XXX ± MATERIAL FINISH DO NOT SCALE DRAWING

APPROVALS	BY	DATE
DRAWN	JOE B.	7/9/93
CHECKED	N/A	N/A
DESIGN	MH	10/1/93
MFGR. ENG.	N/A	N/A
PROJ. ENG.	MT	9/30/93
Q.A.	KK	10/1/93
MFG. ENG.	TS	10/1/93

BREAK ALL SHARP EDGES & CORNERS

SPELLMAN HIGH VOLTAGE ELECTRONICS CORPORATION

SCHEMATIC DIAGRAM
POWER BOARD
PTV10-40P/N200/350

SIZE	CAGE IDENT NO.	DRAWING NO.	REV
D	10610	440549-TAB	D2

SCALE: NONE | FILE: 440549TBD2.SCH | SHEET 1 OF 10

WARNING

DANGEROUS VOLTAGES MAY BE PRESENT ON THIS EQUIPMENT THAT MAY BE FATAL.

OBSERVE EXTREME CAUTION WHEN OPERATING AND WORKING NEAR HIGH VOLTAGE DEVICES.

NEVER TOUCH ANY HIGH VOLTAGE ASSEMBLIES THAT ARE SUSPECTED TO BE ENERGIZED OR CHARGED.

DO NOT HANDLE OR COME WITHIN THE PROXIMITY OF HIGH VOLTAGE CONNECTIONS UNTIL ALL EQUIPMENT IS OFF AND THE SET-UP'S CAPACITANCE IS DISCHARGED.

FAILURE TO FOLLOW SAFETY PROCEDURES MAY BE FATAL.

Safety Considerations:

When working with high voltage extreme caution must be observed. It is *highly* recommended that all high voltage points that are not insulated be contained to prevent accidental shock. The recommended method of containing exposed high voltage points is to place those points inside an enclosure that has safety interlocks on the door or access panel. The safety interlock should be connected to the control of the high voltage source so that when the door or access panel is opened the generation of high voltage is terminated and any charge is dissipated.

This enclosure could be a grounded metal mesh cage or a small box constructed of an insulator depending upon the potential that is exposed. Follow the guidelines in the Spacing section to determine the proper enclosure size.

When a compact enclosure is built using an insulating material, it is extremely important that the guidelines for creepage distance be observed to prevent arcing through the seams of the enclosure. See Spacing section.

When building an enclosure from polycarbonate use 1/4" thick material for voltages below 30kV and 3/4" material for voltages up to 100kV. It is strongly recommended that a grounded cage be used to contain exposed voltages above 100kV.

Grounding:

All devices used in association with high voltage ***must*** be properly grounded. If improper grounding is used, the normally safe points of the device can become energized to a dangerous potential. To insure a good ground, follow the manufacturer's recommended grounding techniques and follow these simple guidelines:

- ☞ *Install separate ground connection in addition to the one in the power connection.*
- ☞ *Use heavy gauge wire for all ground connections (10 AWG minimum).*
- ☞ *Ground connections should be made to earth ground, such as a copper cold water pipe or similar system.*
- ☞ *Insure that all connections are secure.*

Spacing:

For safe and proper operation, all exposed high voltage points must be adequately spaced away from all ground potentials, especially human beings. High voltage has the ability to jump across open distances. High voltage will also creep along surfaces. To insure safe operation and to prevent unintentional arcs, sparks and discharges from high voltage points, follow these guidelines:

- ☞ *All objects at ground potential **must** be placed away from all exposed high voltage points at a minimum distance of 1 inch for every 7,500 volts, e.g. 50kV requires a spacing of at least 6.7 inches.*
- ☞ *Allow a creepage distance of 1 inch for every 7,500 volts for insulators placed in contact with high voltage points.*

Spellman High Voltage Electronics Corporation 475 Wireless Blvd., Hauppauge, N.Y. 11788 (516) 435-1600 FAX(516) 435-1620

STANDARD TEST PROCEDURES

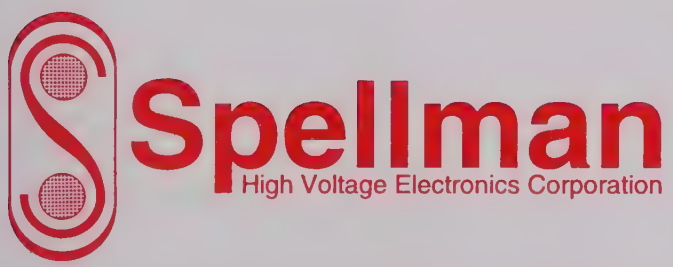
and

SAFETY PRACTICES

for

HIGH VOLTAGE POWER SUPPLIES

with Glossary of Terms



Leading The Way In High Voltage Technology

Summer, 1994

Spellman

High Voltage Electronics Corporation

Leading The Way In High Voltage Technology

HV POWER SUPPLY SELECTOR

7 Fairchild Avenue Plainview, NY 11803 • (516) 349-8686 • FAX (516) 349-8699 • TWX 510-221-2155

Power	100-1500V	1-15kV	15-30kV	30-60kV	60-120kV	>120kV	Model
LABORATORY SUPPLIES							
10W		●	●				CZE1000R
10W-480W		●	●	●	●	●	RHR
10W-1.2kW		●	●	●	●	●	SL
4kW-12kW		●	●	●			SA4
6kW-18kW		●	●	●	●		SR6
6kW-24kW		●					CC6
3kW-4kW				●			DF3
3kW-4kW				●			FF3
18kW				●			XR18
15kW-60kW						●	CT200
9-85kW			●				MG9
MODULES							
3-5W	●						MR
1.5-5W		●					MM
10W		●	●				MP
10W		●	●				CZE2000
1-30W		●	●				WRM
30W		●	●				EPM
60W		●	●	●			SMS
200W-350W		●	●	●			PTV
1W-100kW		●	●	●	●	●	CUSTOM

TABLE OF CONTENTS

TABLE OF CONTENTS i

STANDARD TEST PROCEDURES

1. PURPOSE 1

2. HIERARCHY 1

    2.1 Standard Test Procedure 2
    2.2 Specification Control Drawing 2
    2.3 Model Specific Test Procedures 2

3. HIGH VOLTAGE POWER SUPPLY LOADING METHODS 2

    3.1 Constant Load 2
    3.2 Changing Load 3
        3.2.1 Manual Switch 3
        3.2.2 Electron Tube Switch 4

4. VOLTAGE CALIBRATION AND RANGE 4

    4.1 Test Set Up 4
    4.2 Measurement of High Voltage Power Supply Parameters 5
    4.3 Monitor Instrumentation 6
        4.3.1 John Fluke Model 8810A 6
        4.3.2 John Fluke Model 8840A 6
    4.4 Test Method 6

5. OUTPUT VOLTAGE REGULATION, STATIC AND DYNAMIC 7

    5.1 Definition 7
    5.2 Test Set-Up, STATIC REGULATION 8
    5.3 Test Method, STATIC LOAD REGULATION 8
    5.4 Test Method, STATIC LINE REGULATION 8
    5.5 Test Method, DYNAMIC LOAD REGULATION 8
    5.6 Test Method, DYNAMIC LINE REGULATION 9

6. OUTPUT CURRENT REGULATION 9

7. CURRENT LIMIT 9

8. SHORT CIRCUIT 10

9. INPUT CURRENT 10

10. RIPPLE 11

    10.1 Ripple Measurement Techniques 11
    10.2 Test Method 12

11. NOTES: 13

HIGH VOLTAGE SAFETY PRACTICES

1. SCOPE 15

2. TEST AREAS SAFETY PRACTICES 16

3. CONTROL & MEASUREMENT CIRCUITS 16

4. SAFETY RULES 16

5. SAFETY INSPECTION 16

6. GROUNDING & SHORTING 17

7. SPACING 17

8. HIGH-POWER TESTING 17

9. GENERAL 18

GLOSSARY 19

jps 3/21/94 PRC_COMB.DOC

STANDARD TEST PROCEDURES

The following pages provide generalized descriptions of the tests used by SPELLMAN HIGH VOLTAGE ELECTRONICS CORPORATION in its Quality Control program. These generalized descriptions cover tests on a large number of different models which vary widely in output voltage, output current, and other operating parameters.

Detailed test data sheets are available for most models. These individual test data sheets delineate the explicit requirements and permissible acceptance levels for each item to be tested. For additional information, please contact the SPELLMAN Engineering/Test Department.

WARNING!

DANGEROUS VOLTAGES MAY BE PRESENT ON THIS EQUIPMENT WHICH MAY BE FATAL.

Make certain all equipment is SECURELY grounded.

Do not touch connections unless equipment is off and internal and load capacitances are discharged.

Do not ground yourself or work under wet or damp conditions.

Failure to follow Safety Procedures may be fatal.

1. PURPOSE

It is the purpose of this procedure to delineate standard tests to be performed on all power supplies manufactured by Spellman High Voltage. It is intended to be used as a stand-alone procedure and in conjunction with other procedures.

2. HIERARCHY

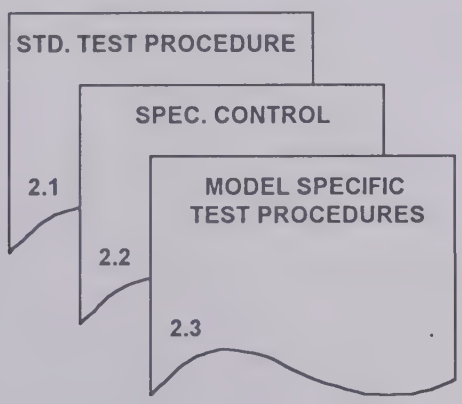


Figure 1. Document Organization

2.1 Standard Test Procedure

Describes generic test to be performed on all power supplies. This combined with the Test Data Sheet provides the parameters for verifying operation of the power supply.

2.2 Specification Control Drawing

Can contain additions or deletions to the standard test procedure.

2.3 Model Specific Test Procedures

Contain elements of both the standard test procedure and the specification control drawing in addition to any detailed instructions needed to verify operation of the supply.

3. HIGH VOLTAGE POWER SUPPLY LOADING METHODS

3.1 Constant Load

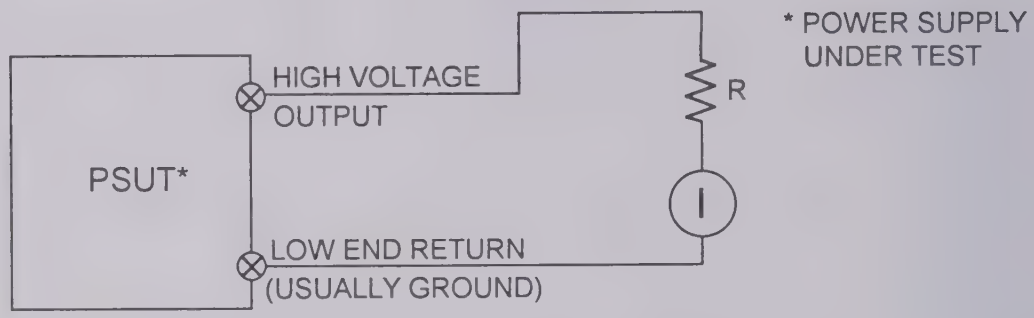


Figure 2. Constant Load Test Set Up

Figure 2 shows a resistor, R, in series with a current meter, I, across the terminals of the P.S.U.T.

CAUTION: The lead from the High Voltage terminal should be high voltage wire. If high voltage wire is not available, ordinary hook-up wire may be used providing reasonable care is exercised to avoid contact with ground circuits.

Resistors must be selected with appropriate voltage and wattage ratings for the specified load requirements. Attention must be given to the physical mounting arrangement, in order to avoid voltage breakdown.

The appropriate current meter, I, should be connected in series with the load resistor, R, in the LOW END RETURN line. This holds the meter at safe, low potentials.

3.2 Changing Load

3.2.1 Manual Switch

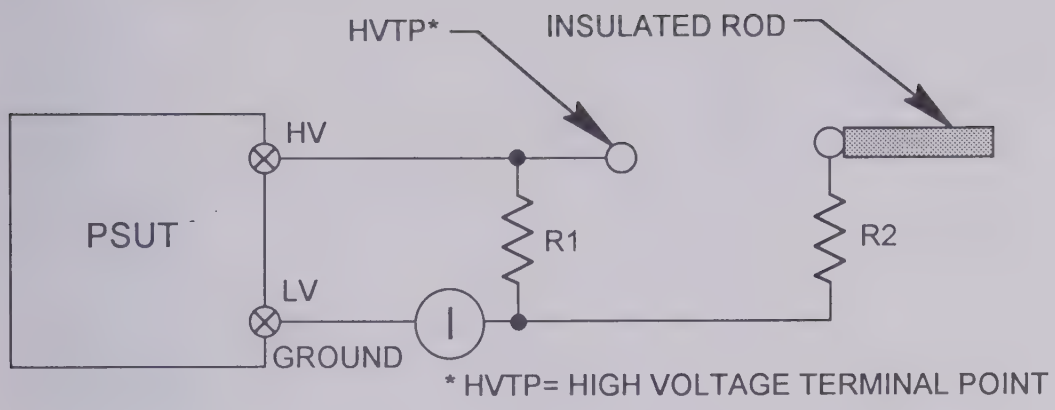


Figure 3. Test Set Up for Changing Load

Figure 3 shows resistor R1 directly connected to the P.S.U.T. R1 is selected to load the P.S.U.T. for the *minimum* specified load. For a NO LOAD condition, R1 is infinite and, thus, open circuited.

Resistor R2 is selected as required to achieve the desired load condition. The "low end" of the load is returned to the current monitor, I. The "high end" of the R2 resistor is connected by an appropriate lead to an insulated stick or rod ("Lexan" or other acrylic material is recommended). A three foot length should be adequate for most applications below 100 kilovolts. Hold this stick in your hand, making sure that you grip it at the end opposite from the lead termination. This allows safe and easy connection of the High Voltage Terminal Point.

Note that when R2 is connected as shown, I indicates the total load current, the sum of the load in R1 and the load in R2.

When measurements are completed, the load is disconnected from the High Voltage Terminal Point, by manually removing the insulated rod from contact with the H.V.T.P.

NOTE: When not connected to the H.V.T.P., the "high end" of R2 as well as the "low end" are both at safe, low potentials with respect to ground, and are safe to handle.

3.2.2 Electron Tube Switch

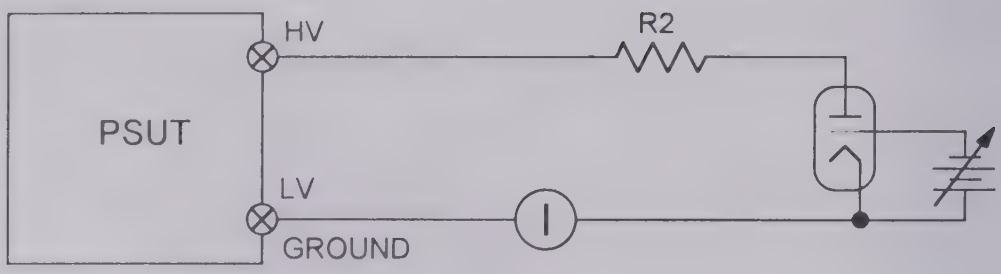


Figure 4. Electron Tube Switch

The circuit of Figure 4 shows a vacuum tube used to cycle the load ON and OFF very quickly. If the grid of the tube is switched from near zero bias to a sufficient negative bias, the tube can be controlled as a switch. Rapidly cycling the load ON and OFF and observing the voltage characteristics is commonly referred to as "Dynamic Load Regulation". Refer to Section 5 for more details.

In addition, the tube can be controlled to provide continuous load adjustment by proper variation of the grid bias. An easy method of attaining bias is by the use of an adjustable cathode resistor.

The manual switch explained in the previous paragraphs are applicable for power supplies with either positive or negative polarity. The electron tube circuit of Figure 4 is shown for a high voltage power supply with positive polarity only. A tube can be used for power supplies with negative polarity by connecting the plate end to low voltage and the cathode end to high voltage. In this case, since the filament and grid supplies will be at high voltage, isolation techniques must be used.

4. VOLTAGE CALIBRATION AND RANGE

This paragraph describes the test set up and method used to measure the output voltage in accordance with the specifications of the specific test data sheet for a given power supply.

4.1 Test Set Up

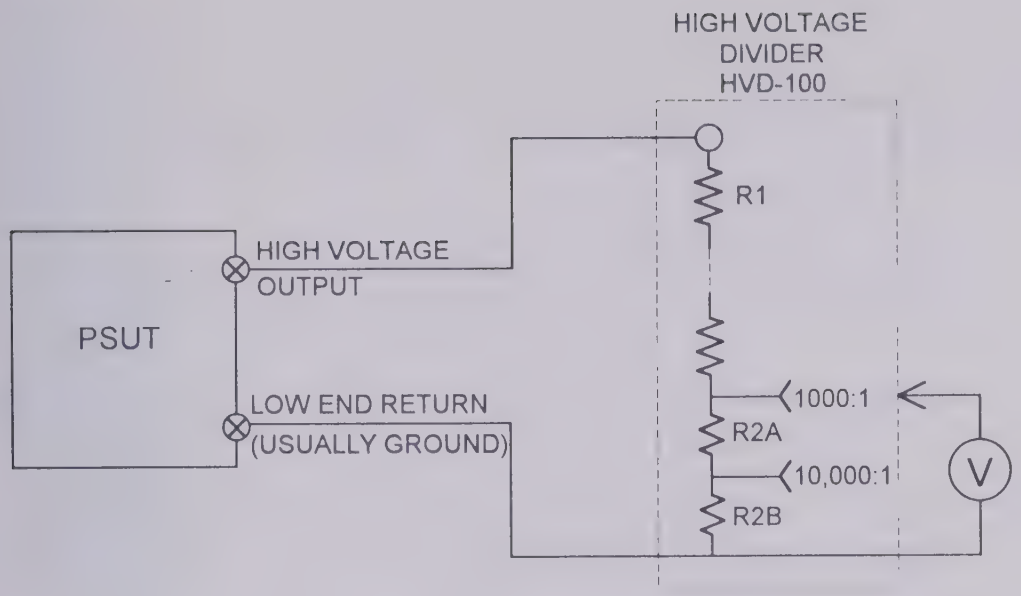


Figure 5. Test Set Up

4.2 Measurement of High Voltage Power Supply Parameters

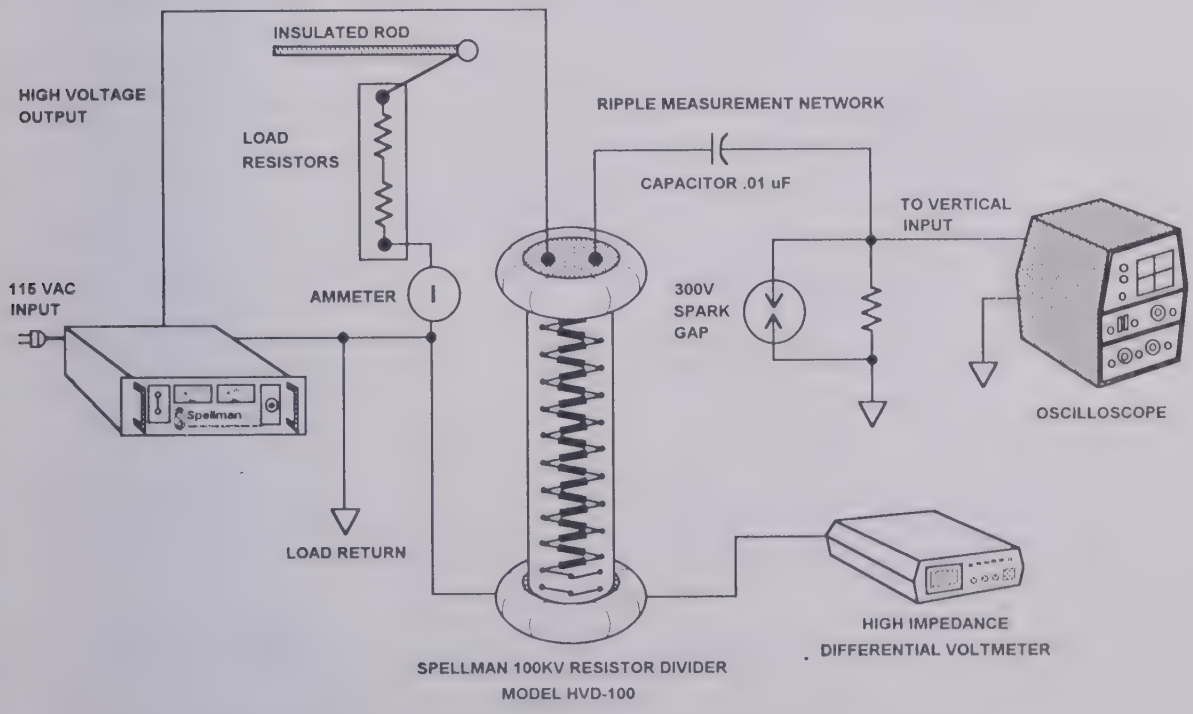


Figure 6. High Voltage Power Supply Test Set Up

4.3 Monitor Instrumentation

The instrument used to measure the divider output voltage must have high input impedance in order to minimize the possibility of introducing errors in measurement due to the loading effects of metering instruments on R2A or R2B (Figure 5). Spellman uses either of two instruments described below for metering (M) in test set-up diagrams, Figure 5 or 6 depending on resolution requirements.

4.3.1 John Fluke Model 8810A

Accuracy of reading including stability: $\pm$ 0.01% of input
Input impedance: $\geq$1000 Megohms (200mV, 2V, 20V ranges)
Resolution: 10 ppm of range

4.3.2 John Fluke Model 8840A

Accuracy of reading including stability: $\pm$.005%
Input impedance: $\geq$10,000 Megohms (200mV, 2V, 20V ranges)
Resolution: 1 ppm of range

4.4 Test Method

4.4.1 Connect the HIGH VOLTAGE DIVIDER (HVD) and VOLTMETER as shown in the Test Set-up diagram, Figure 6. The connection between the high voltage output terminal of the P.S.U.T. (Power Supply Under Test) and the high voltage input terminal of the HIGH VOLTAGE DIVIDER should be made with high voltage lead wire.

4.4.2 Connect the P.S.U.T. to a source of input power in accordance with the unit specification. Appropriate input voltage and current monitoring equipment should be included in the test set-up.

4.4.3 All required external adjustment controls should be connected in accordance with the unit specification. Using the specific test data sheet which establishes the proper input voltage conditions and output voltage settings, measure the output voltage according to the above procedures.

4.4.4 Energize the P.S.U.T., exercising reasonable precautions against high voltage hazards.

4.4.5 Measure the output voltage under desired conditions of input voltage and adjustment of voltage controls.

4.4.6 The above measurement is described for what is essentially a "NO LOAD" condition. This is due to the fact that the SPELLMAN High Voltage Divider has an input impedance of 1000 Megohms drawing negligible load current in almost all cases.

Measurements under load may be made as desired by connecting appropriate high voltage load resistors, or other loading devices, across the PSUT, as seen in Figure 6. Current meters should be connected in series with the load resistors in the grounded end to keep the meters at safe potentials. NOTE: See Section 3 for additional information on loading methods.

5. OUTPUT VOLTAGE REGULATION, STATIC AND DYNAMIC

5.1 Definition

In general, most power supply manufacturers in the United States limit the use of the term "regulation" to variations in the output voltage which result directly from changes in the input power source and/or the load resistance.

"Regulation" then, as defined by ***Spellman***, and most other manufacturers, specifically *excludes* variations resulting from changes in *temperature* and *time*. Thus, regulation is measured at "constant temperature" and "short" time intervals, where "short" means the time required to make the measurements.

In addition to the two basic components of regulation, i.e. LOAD REGULATION and LINE REGULATION, regulation is further differentiated as STATIC or DYNAMIC variation.

Dynamic regulation is concerned with the output voltage transient response resulting from a line or load change. Of interest are peak deflection and recovery time. ***Spellman*** defines recovery time as that time required to return from the peak deflection point to within 10% of the new static level. The sketch below details this.

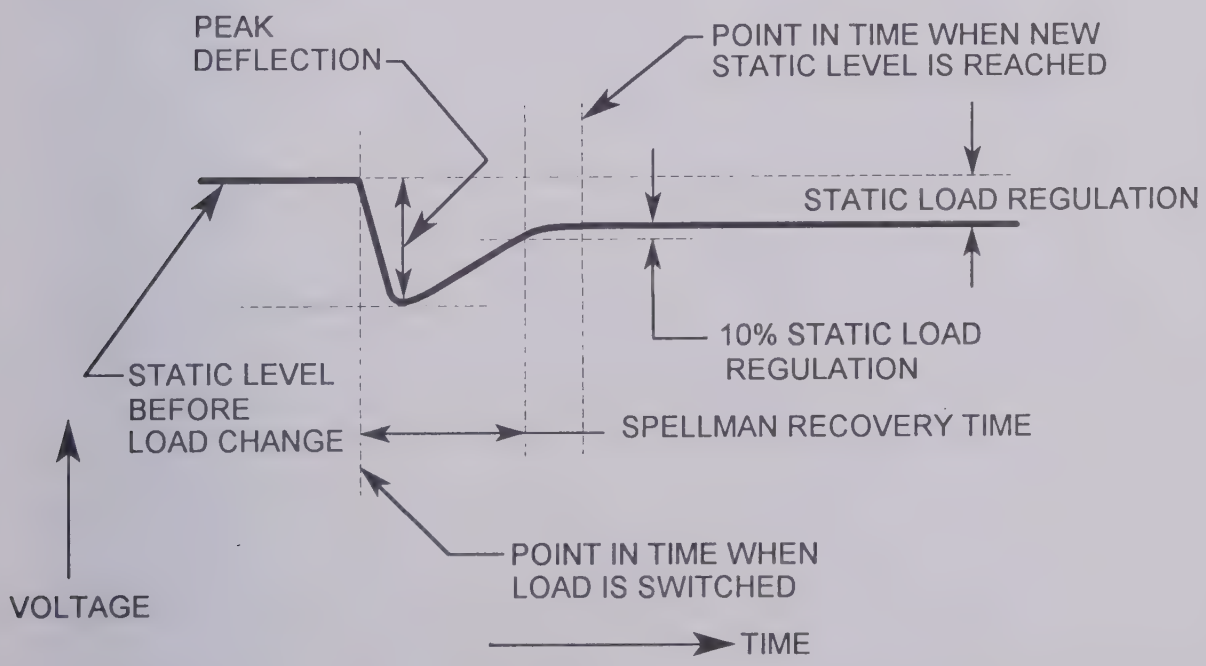


Figure 7. Static and Dynamic Regulation Waveform

5.2 Test Set-Up, *STATIC REGULATION*

5.2.1 Connect the output voltmeter circuit as described in Section 4.

5.2.2 Connect the PSUT to a source of input power in accordance with the unit specification. Appropriate input voltage and current monitoring equipment should be included in the test set-up. Provide for input power adjustability as required by the specification.

5.2.3 Select a loading method (as described in Section 3) which is suitable to the unit specification. Make the necessary connections.

5.3 Test Method, STATIC LOAD REGULATION

5.3.1 With input voltage maintained constant, make the specified load change using one of the techniques of Section 3.

5.3.2 Observe the change in output voltage as read on the voltage monitor. Record for "LOAD ON".

5.3.3 Repeat for "LOAD OFF".

5.3.4 The above measurements may be made at minimum, maximum and nominal input voltage conditions in accordance with the unit specification. They also may be made at different output voltage conditions, as specified.

5.4 Test Method, STATIC LINE REGULATION

5.4.1 The same set-up as in Section 5.2 above is used.

5.4.2 With output voltage level and load condition set per specification, adjust the input voltage from minimum to maximum.

5.4.3 Observe the change in output voltage as read on the voltage monitor. Record.

5.5 Test Method, DYNAMIC LOAD REGULATION

5.5.1 Connect the output voltage monitor as described in Section 5.

5.5.2 With the input voltage maintained constant at its nominal value, establish a square-wave load or pulse load condition as desired.

5.5.3 Check that the load current is switching properly by observing the current wave-shape across a current sensing resistor in the "low end" return of the power supply.

5.5.4 Observe the dynamic response of the output voltage by using a ripple checker as described in Figure 12.

5.5.5 Record the results.

5.6 Test Method, DYNAMIC LINE REGULATION

5.6.1 With load current maintained at a constant level, establish the necessary input voltage switching characteristic.

5.6.2 Observe the dynamic response of the output voltage by using a ripple checker as described in Figure 12.

5.6.3 Record the results.

6. OUTPUT CURRENT REGULATION

6.1 This power supply parameter applies to "Constant Current" or "Current Regulated" supplies. All aspects of "regulation" as described in section 5 above apply here except for the method of measurement.

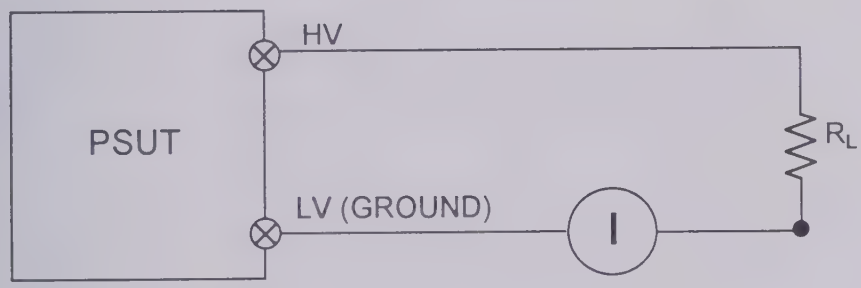


Figure 8. Current Regulation

In Figure 8, the load resistance is represented by R_L. In a current regulated supply, the load resistor, R_L, changes from zero, at the short circuit condition, to some finite value at the rated output voltage condition. The supply cannot maintain regulation into an open circuit, obviously. Thus, load changes are accomplished by "shorting" a portion of the rated load resistor. A current meter, in series with the "low end" of the power supply is used for monitoring the current.

7. CURRENT LIMIT

7.1 This power supply parameter applies to power supplies which although not current regulated, have circuits which will limit the absolute value of the output current.

7.2 Referencing Figure 8, resistor R_L is shorted and the power supply is turned on. The output current is monitored for its peak value and this value is usually 110% of the rated output current.

8. SHORT CIRCUIT

8.1 This test is performed to simulate an arcing condition.

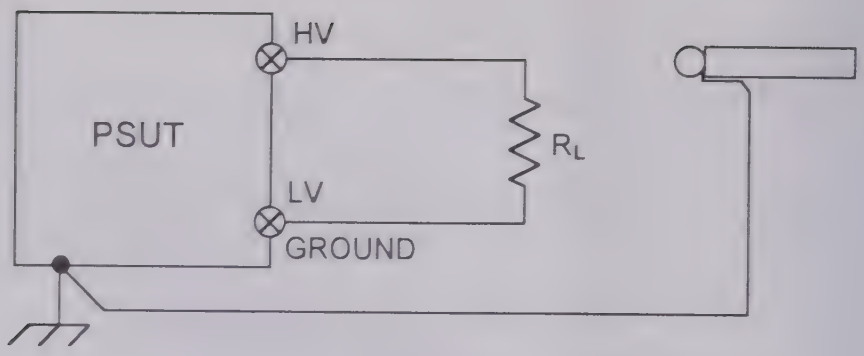


Figure 9. Short Circuit Arcing Test

Using the Plexiglas stick with the conductor connected to ground with a #4 wire, a short circuit condition is applied to the PSUT while the PSUT is energized at full output voltage.

9. INPUT CURRENT

9.1 Input current refers to the current the PSUT draws from its power source (either low voltage DC, or AC mains) during full power operation.

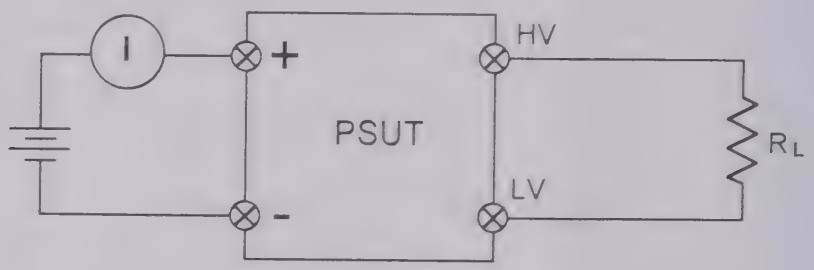


Figure 10. DC Input Current Measurement

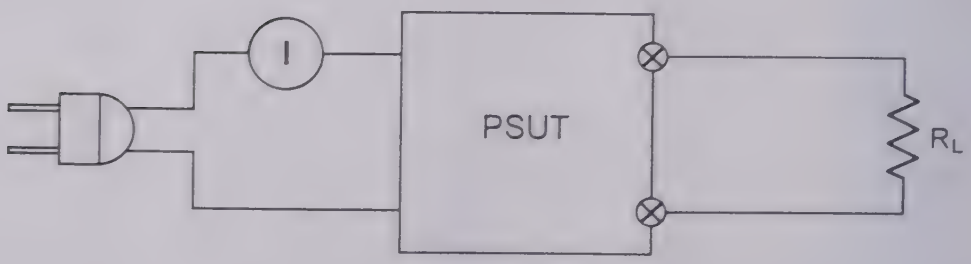


Figure 11. AC Input Current Measurement

A digital multimeter is placed in series with either the positive output of a source or the "HOT" lead of an AC source and the power supply is energized. The parameter is measured at 100% of rated output at nominal input.

10. RIPPLE

10.1 Ripple Measurement Techniques

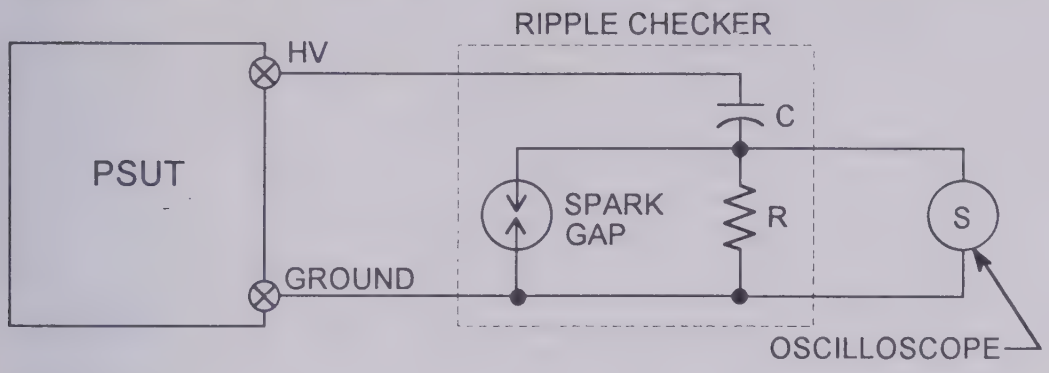


Figure 12. Ripple Measurement

Figure 12 illustrates the technique of using a DC blocking capacitor, C, in series with the power supply output terminal, for the purpose of passing the AC component in the output voltage directly to the oscilloscope, S. Resistor, R, and spark gap, SG, protect the oscilloscope against surges in the output voltage which could be transferred directly through the blocking capacitor to the scope.

The value of C and R must be selected to pass the ripple frequencies of interest with negligible attenuation. The oscilloscope input impedance and frequency response also introduce an error which must be accounted for.

The error in 60 Hz ripple measurements is small for C≥0.01uF and R≅1 to 10 Megohms. For high frequency components proportionally smaller capacitance values are acceptable.

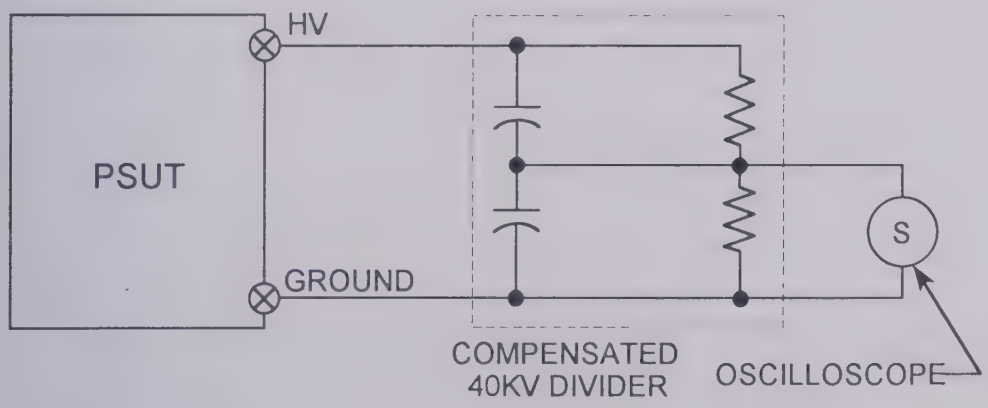


Figure 13 Ripple Measurement

Figure 13 illustrates the use of a compensated 40kV divider for ripple measurements. Although the compensated divider gives an accurate measurement, it suffers from two deficiencies. First, a true no load ripple measurement cannot be made, since the divider itself has 100 Megohms input resistance.

Second, when the power supply output ripple is relatively low, the 1000:1 divider ratio may attenuate the AC component at the divider output to a level which may be difficult to read.

10.2 Test Method

10.2.1 Set all operating parameters as required by the unit specified. These operating parameters must include all the following:

Output Voltage setting
Load Current condition
Input Voltage condition

10.2.2 Read the ripple in peak-to-peak volts on the oscilloscope. Record.

10.2.3 Divide the measured peak-to-peak value by $2\sqrt{2}$ when rms readings are desired (if the ripple is sinusoidal).

NOTES

Excerpts from IEEE Standard 510-1983. IEEE Recommended Practices for Safety in High-Voltage and High-Power Testing

1. SCOPE

Excerpts from IEEE Standard 510-1983 have been listed in this section in order to caution all personnel dealing with high voltage applications and measurements and to provide recommended safety practices with regard to electrical hazards.

Considerations of safety in electrical testing apply not only to personnel but to the test equipment and apparatus or system under test. These recommended practices deal generally with safety in connection with testing in laboratories, in the field, and of systems incorporating high voltage power supplies, etc. For the purposes of these recommended practices a voltage of approximately 1,000 volts has been assumed as a practical minimum for these types of tests. Individual judgment is necessary to decide if the requirements of these recommended practices are applicable in cases where lower voltages or special risks are involved.

1.1 All ungrounded terminals of the test equipment or apparatus under test should be considered as energized.

1.2 Common ground connections should be solidly connected to both the test set and the test specimen. As a minimum, the current capacity of the ground leads should exceed that necessary to carry the maximum possible ground current. The effect of ground potential rise due to the resistance and reactance of the earth connection should be considered.

1.3 Precautions should be taken to prevent accidental contact of live terminals by personnel, either by shielding the live terminals or by providing barriers around the area.

1.4 The circuit should include instrumentation for indicating the test voltages.

1.5 Appropriate switching and, where appropriate, an observer should be provided for the immediate de-energization of test circuits for safety purposes. In the case of dc tests, provisions for discharging and grounding charged terminals and supporting insulation should also be included.

1.6 High-voltage and high-power tests should be performed and supervised by qualified personnel.

2. TEST AREA SAFETY PRACTICES

2.1 Appropriate warning signs, for example, DANGER - HIGH VOLTAGE, should be posted on or near the entrance gates.

2.2 Insofar as practical, automatic grounding devices should be provided to apply a visible ground on the high-voltage circuits after they are de-energized. In some high-voltage circuits, particularly those in which elements are changed from one setup to the next, this may not be feasible. In these cases the operator should attach a ground to the high-voltage terminal using a suitably insulated handle. In the case of several capacitors connected in series, it is not always sufficient to ground only the high-voltage terminal. The exposed intermediate terminals should also be grounded. This applies in particular to impulse generators where the capacitors should be short-circuited and grounded before and while working on the generator.

2.3 Safe grounding of instrumentation should take precedence over proper signal grounding unless other special precautions have been taken to ensure personnel safety.

3. CONTROL & MEASUREMENT CIRCUITS

3.1 Leads should not be run from a test area unless they are contained in a grounded metallic sheath and terminated in a grounded metallic enclosure, or unless other precautions have been taken to ensure personnel safety. Control wiring, meter connections, and cables running to oscilloscopes fall into this category. Meters and other instruments with accessible terminals should normally be placed in a metal compartment with a viewing window.

3.2 Temporary Circuits.

3.2.1 Temporary measuring circuits should be located completely within the test area and viewed through the fence. Alternatively, the meters may be located outside the fence, provided the meters and leads, external to the area, are enclosed in grounded metallic enclosures.

3.2.2 Temporary control circuits should be treated the same as measuring circuits and housed in a grounded box with all controls accessible to the operator at ground potential.

4. SAFETY RULES

A set of safety rules should be established and enforced for the laboratory or testing facilities. A copy of these should be given to, and discussed with, each person assigned to work in a test area. A procedure for periodic review of these rules with the operators should be established and carried out.

5. SAFETY INSPECTION

A procedure for periodic inspection of the test areas should be established and carried out. The recommendations from these inspections should be followed by corrective actions for unsafe equipment or for practices that are not in keeping with the required regulations.

NOTE: A safety committee composed of several operators appointed on a rotating basis has proven to be effective, not only from the inspection standpoint but also in making all personnel aware of safety.

6. GROUNDING & SHORTING

6.1 The routing and connections of temporary wiring should be such that they are secure against accidental interruptions that may create hazard to personnel or equipment.

6.2 Devices which rely on a solid or solid/liquid dielectric for insulation should preferably be grounded and short-circuited when not in use.

6.3 Good safety practice requires that capacitive objects be short-circuited in the following situations:

6.3.1 Any capacitive object which is not in use but may be in the influence of a dc electric field should have its exposed high-voltage terminal grounded. Failure to observe this precaution may result in a voltage induced in the capacitive object by the field.

6.3.2 Capacitive objects having a solid dielectric should be short-circuited after dc proof testing. Failure to observe this precaution may result in a buildup of voltage on the object due to dielectric absorption in the insulation. The short circuit should remain on the object until the dielectric absorption has dissipated or until the object has been reconnected to a circuit.

NOTE: It is good practice for all capacitive devices to remain short-circuited when not in use

6.3.3 Any open circuited capacitive device should be short-circuited and grounded before being contacted by personnel.

7. SPACING

7.1 All objects at ground potential **must** be placed away from all exposed high voltage points at a minimum distance of 1 inch (25.4 mm) for every 7,500 Volts, e.g. 50 kV requires a spacing of at least 6.7 inches (171 mm).

7.2 Allow a creepage distance of 1 inch (25.4 mm) for every 7,500 Volts for insulators placed in contact with high voltage points.

8. HIGH-POWER TESTING

8.1 High-power testing involves a special type of high-voltage measurement in that the level of current is very high. Careful consideration should be given to safety precautions for high-power testing due to this fact. The explosive nature of the test specimen also brings about special concern relating to safety in the laboratory.

8.2 Protective eye and face equipment should be worn by all personnel conducting or observing a high-power test where there is a reasonable probability that eye or face injury can be prevented by such equipment.

NOTE: Typical eye and face hazards present in high-power test areas include intense light (including ultraviolet), sparks, and molten metal.

8.3 Safety glasses containing absorptive lenses should be worn by all personnel observing a high-power test even when electric arcing is not expected. Lenses should be impact-resistant and have shade numbers consistent with the ambient illumination level of the work area but yet capable of providing protection against hazardous radiation due to any inadvertent electric arcing.

8.4 Whenever electric arcs are to be directly observed, safety glasses containing filter lenses should be worn by all personnel observing the electric arc test.

9. GENERAL

9.1 All high-voltage generating equipment should have a single obvious control to switch the equipment off under emergency conditions.

9.2 All high-voltage generating equipment should have an indicator which signals that the high-voltage output is enabled.

9.3 All high-voltage generating equipment should have provisions for external connections (interlock) which, when open, cause the high-voltage source to be switched off. These connections may be used for external safety interlocks in barriers or for a foot or hand operated safety switch.

9.4 The design of any piece of high-voltage test equipment should include a failure analysis to determine if the failure of any part of the circuit or the specimen to which it is connected will create a hazardous situation for the operator. The major failure shall be construed to include the probability of failure of items that would be overstressed as the result of the major failure. The analysis may be limited to the effect of one major failure at a time, provided that the major failure is obvious to the operator.

GLOSSARY OF TERMS

AC LINE FILTER: A circuit filter placed in the ac line to condition or smooth out variations that are higher in frequency than the line frequency.

ALTERNATING CURRENT(ac): A periodic current the average value of which over a period is zero.

AMBIENT TEMPERATURE: The average temperature of the environment immediately surrounding the power supply. For forced air-cooled units, the ambient temperature is measured at the air intake. See also Operating Temperature, Storage.

ANODE: Electron tube or valve) An electrode through which a principal stream of electrons leaves the inter electrode space. (IEEE Std 100-1988)

APPARENT POWER: A value of power for AC circuits that is calculated as the product of rms current times rms voltage, without taking the power factor into account.

ARC: A discharge of electricity through a gas, normally characterized by a voltage drop in the immediate vicinity of the cathode approximately equal to the ionization potential of the gas. (IEEE Std 100-1988)

AUTO-TRACKING OPERATION: A master-slave connection of two or more supplies each of which has one of its output terminals in common with one of the output terminals of all of the other supplies.

AUTOMATIC CROSSOVER: The characteristic of a power supply having the capability of switching its operating mode automatically as a function of load or setting from the stabilization of voltage to the stabilization of current.

BANDWIDTH: A range of frequencies over which a certain phenomenon is to be considered.

BEAM SUPPLY: Power supply which provides the accelerating energy for the electrons or ions.

BIAS SUPPLY: Power supply which provides the voltage to the grid or control electrode.

BIPOLAR POWER SUPPLY: A special power supply which responds to the sense as well as the magnitude of a control instruction and is able to linearly pass through zero to produce outputs of either positive or negative polarity.

BLEED: A low current drain from a power source.

BLEEDER RESISTOR:. A resistor added to a circuit for the purpose of providing a small current drain, usually to provide a load for improving output voltage stability, or to assure discharge of capacitors.

BREAKDOWN VOLTAGE: A voltage level at which dielectric insulation fails by excessive leakage current or arcing.

BUFFER: An isolating circuit used to prevent a driven circuit from influencing a driving circuit. (IEEE Std 100-1988)

CAPACITANCE, DISTRIBUTED: The capacitance in a circuit resulting from adjacent turns on coils, parallel leads and connections.

CAPACITANCE: Inherent property of an electric circuit or device that opposes change in voltage and may store energy in an electrostatic field.

CAPACITIVE COUPLING: Coupling of a signal between two circuits due to discrete or parasitic capacitance between the circuits.

CATHODE-RAY TUBE: An electron-beam tube in which the beam can be focused to a small cross-section on a luminescent screen and varied in position and intensity to produce a visible pattern. (IEEE Std 100-1988)

CATHODE: An electrode through which a primary stream of electrons enters the inter electrode space. (IEEE Std 100-1988)

CHASSIS GROUND: The voltage potential of the chassis.

CLAMP DIODE: A diode in either a clipper or clamp circuit.

CLOSED-LOOP CONTROL SYSTEM: (control system feedback) A control system in which the controlled quantity is measured and compared with a standard representing the desired performance. Any deviation from the standard is fed back into the control system to reduce the deviation.

COMPLIANCE RANGE: Range of voltage needed to sustain a given constant current throughout a range of load resistance.

COMPLIANCE VOLTAGE: The output dc voltage of a constant current supply.

CONSTANT CURRENT LIMITING CIRCUIT: Holds the output current at some maximum value whenever an overload is experienced.

CONSTANT CURRENT: A power supply which regulates for current regardless of load resistance changes.

CONSTANT VOLTAGE POWER SUPPLY: A power supply that regulates its output voltage within specified limits, against changes in line, load, ambient temperature and time.

CONSTANT VOLTAGE/CONSTANT CURRENT POWER SUPPLY: A power supply that operates as a constant voltage power supply or a constant current power supply depending on load conditions.

CONTINUOUS DUTY: A requirement of service that demands operation at a substantially constant load for an indefinitely long time.

CONTROL CIRCUIT: A circuit in a closed-loop system, typically containing an error amplifier, which controls the operation of the system to achieve regulation.

CONTROL GRID: A grid, ordinarily placed between the cathode and an anode, for use as a control electrode. (IEEE Std 100-1988)

CONTROL LOOP: A feedback circuit used to control an output signal. See also Loop.

CONVERTER (DC TO DC CONVERTER): A device that delivers DC power when energized from a DC source. AC is generated as an intermediate step in the DC to DC process. Rectification of an inverter output results in a DC to DC converter.

CORONA EXTINCTION VOLTAGE: (CEV) (corona measurement). The highest voltage at which continuous corona of specified pulse amplitude no longer occurs as the applied voltage is gradually decreased from above the corona inception value.

CORONA INCEPTION VOLTAGE: (CIV) (corona measurement). The lowest voltage at which continuous corona of specified pulse amplitude occurs as the applied voltage is gradually increased.

CREEPAGE DISTANCE: The shortest distance separating two conductors as measured along a surface touching both conductors.

CROSS-REGULATION: In a multiple output power supply, the percent voltage change at one output caused by the load change on another output.

CROSSOVER, VOLTAGE/CURRENT: Voltage/ Current crossover is that characteristic of a power supply that automatically converts the mode of operation from voltage regulation to current regulation (or vice versa) as required by preset limits.

CROWBAR: An over voltage protection method which shorts the power supply output to ground to protect the load when an over voltage fault is detected.

CSA: Abbreviation for Canadian Standards Association.

CURRENT LIMITING: The action of limiting the output current of a constant voltage supply to some predetermined maximum value (fixed or adjustable) and automatically restoring the output voltage to its normal value when the overload or short circuit is removed.

CURRENT MODE: The functioning of a power supply to produce a stabilized output current.

CURRENT MONITOR: An analog power supply signal which is linearly proportional to output current flow.

CURRENT SENSING RESISTOR: A resistor placed in series with the load to develop a voltage proportional to load current.

CURRENT SOURCE: A power source that delivers constant current.

DECAY TIME: See **Fall Time.**

DRIFT: The change in output voltage or current over a specified period of time, following a warm-up period, with all other variables such as line, load, and ambient temperature held constant.

DUTY CYCLE: The ratio of "time on" to "time off" in a recurring event.

DYNAMIC FOCUS: In an electron beam, a means of modulating the focus voltage as a function of the beam position.

DYNAMIC LOAD: A load that rapidly changes from one level to another. To be properly specified, both the total change and the rate of change must be stated.

EARTH: An electrical connection to the earth frequently using a grid or rod(s). See also Ground.

EFFICIENCY: The ratio of total output power to input power, expressed in percent.

ELECTRON BEAM: A collection of electrons normally accelerated between cathode and anode in an electron beam system.

ELECTRON GUN: A source of electrons, such as a cathode, that produces an electron beam.

ELECTROPHORESIS: A movement of colloidal ions as a result of the application of an electric potential. (IEEE Std 100-1988).

EMI: Abbreviation for Electromagnetic Interference, which is the generation of unwanted noise during the operation of a power supply or other electrical or electronic equipment..

EMISSION CURRENT: The current resulting from electron emission. (IEEE Std 100-1988)

ERROR AMPLIFIER: An operational amplifier, or differential amplifier, in a control loop that produces an error signal whenever a sensed output differs from a reference voltage.

ERROR VOLTAGE: The output voltage of the error amplifier in a control loop.

ESD: Electrostatic Discharge.

FALL TIME: The time required for a pulse to decrease from 90 percent to 10 percent of its maximum positive (negative) amplitude.

FEEDBACK: The process of returning part of the output signal of a system to the input of its control circuit.

FET: Field Effect Transistor.

FIELD EMISSION GUN: An electron gin with an extractor electrode which pulls or extracts electrons off the filament. Extraction is accomplished using a high electric field. An extractor supply is the opposite polarity of the beam supply and it floats on the beam supply.

FIELD EMISSION: Electron emission from a surface due directly to high voltage gradients at the emitting surface. (IEEE Std 100-1988)

FILAMENT CURRENT: The current supplied to a filament to heat it. (IEEE Std 100-1984)

FILAMENT VOLTAGE: The voltage between the terminals of a filament. (IEEE Std 100-1988)

FILAMENT: (electron tube) A hot cathode, usually in the form of a wire or ribbon, to which heat may be supplied by passing current through it.

FILTER: One or more discrete components positioned in a circuit to attenuate signal energy in a specified band of frequencies.

FLASHOVER: A disruptive discharge through air around or over the surface of solid or liquid insulation, between parts of different potential or polarity, produced by the application of voltage wherein the breakdown path becomes sufficiently ionized to maintain an electric arc.

FLOATING NETWORK OR COMPONENTS: A network or component having no terminal at ground potential.

FLOATING OUTPUT: Ungrounded output of a power supply where either output terminal may be referenced to another specified voltage.

FOCUS: (Oscilloscope) Maximum convergence of the electron beam manifested by the minimum spot size on the phosphor screen. (IEEE Std 100-1988)

FOCUSING ELECTRODE: (beam tube) An electrode used to focus an electron beam by adjustment of an applied voltage.

FOLDBACK CURRENT LIMITING: An output protection circuit where the output current decreases as the overload increases. The output current reaches a minimum as the load approaches a short-circuit condition.

FULL BRIDGE CONVERTER: A high power switching circuit in which four transistors are connected in a bridge

FULL WAVE RECTIFIER: Rectifier circuit that produces a dc output for each half cycle of applied alternating current.

GROUND LOOP: An unintentionally induced feedback signal caused by two or more circuits sharing a common electrical ground.

GROUND: An electrical connection to earth or some other conductor that is connected to earth.

GROUNDED: Connected to or in contact with earth or connected to some extended conductive body which serves instead of the earth.

HALF-BRIDGE CONVERTER: A switching power supply design in which two power switching devices are used to drive the transformer primary.

HIGH LINE: Highest specified input operating voltage.

HIGH VOLTAGE ASSEMBLY: The portion of a high voltage power supply which contains the high voltage circuits.

HIPOT: Abbreviation for High Potential, and generally refers to the high voltages used to test dielectric withstand capability for regulatory agency electrical safety requirements.

INHIBIT: The ability to turn off the output of a power supply from a remote location.

INPUT LINE FILTER: A low-pass or band-reject filter at the input of a power supply which reduces line noise fed to the supply.

INPUT SURGE CURRENT: The peak line current which flows during turn-on. Surge current is caused by the charging of the input capacitor, and limited only by the input impedance.

INPUT VOLTAGE RANGE: The high and low input voltage limits within which a power supply or DC/DC converter meets its specifications.

INRUSH CURRENT LIMITING: A circuit which limits the amount of inrush current when a power supply is turned on.

ION BEAM: A collection of ions accelerated in an ion beam system.

ION GUN: A device similar to an electron gun but in which the charged particles are ions.

ISO 9000: A series of international standards for Quality Assurance Management Systems. It establishes the organizational structure and processes for assuring the production of goods and services that meet a consistent and agreed upon level of quality for a company's customers.

ISOLATION: The electrical separation between two circuits, or circuit elements.

JOULE (j): Unit of energy equal to one watt-second.

LEAKAGE CURRENT: A term relating to current flowing between the AC supply wires and earth ground. In power supplies, leakage current usually refers to the 60 Hertz current which flows through the EMI filter capacitors which are connected between the AC lines and ground (Y caps).

LINE REGULATION: The percentage change in output due to the input voltage varying over its specified limits load values, with all other factors constant.

LINE TRANSIENT: A perturbation outside the specified operating range of the input voltage of a power supply.

LINEARITY: The ideal property wherein the change in the value of one quantity is directly proportional to the change in the value of another quantity.

LOAD REGULATION: The change in output voltage or current resulting from a load change.

LOAD: Capacitance, resistance, inductance or any combination thereof, which, when connected across a circuit determines current flow and power delivered.

LOCAL CONTROL: Control over the stabilized output by means located within or on the power supply.

LOGIC ENABLE: The ability to turn a power supply on and off with a logic signal.

LOGIC HIGH: A voltage greater than 2.3V with a maximum of 5.5 volts. Also known as a logic "1".

LOGIC INHIBIT: The ability to turn a power supply off and on with TTL signals.. A logic low allows the power supply to operate. A logic high turns off the power supply

LOGIC LOW: A voltage less than 0.8 volts. Also known as a logic "O".

LONG-TERM STABILITY: The output voltage change of a power supply, in percent, due to time only, with all other factors held constant.

LOOP GAIN: The ratio of the values of a given signal from one point to another in a loop.

LOOP RESPONSE: The speed with which a loop corrects for specified changes in line or load.

LOOP STABILITY: A term referencing the stability of a loop as measured against some criteria, e.g., phase margin and gain margin.

LOOP: The path used to circulate a signal.

LOW LINE: Lowest specified input operating voltage.

MAINS: The utility AC power source.

MASTER-SLAVE OPERATION: A method of interconnecting two or more supplies such that one of them (the master) serves to control the others (the slaves). The outputs of the slave supplies always remain equal to or proportional to the output of the master.

MAXIMUM LOAD: The highest allowable output rating specified of a power supply.

MODULAR: An individual power unit patterned on standard dimensions and capable of being integrated with other parts or units into a more complex and higher power system.

NEGATIVE FEEDBACK: The process by which part of the signal in the output circuit reacts upon the input circuit to counteract the input signal.

NEGATIVE TEMPERATURE COEFFICIENT: A decreasing function with increasing temperature. The function may be resistance, capacitance, voltage, etc.

NO LOAD VOLTAGE: Terminal voltage of a supply when no current is flowing in an external circuit.

NOISE: The aperiodic random component on the power source output which is unrelated to source and switching frequency. Unless specified otherwise, noise is expressed in peak-to-peak units over a specified bandwidth.

OFF-LINE POWER SUPPLY: A power supply which operates off the AC line directly, without using a power transformer prior to rectification and filtering.

OUTPUT CURRENT, MAXIMUM: The maximum output current for which the power supply was designed.

OUTPUT CURRENT LIMITING: A protective feature that keeps the output current of a power supply to predetermined limits during overload.

OUTPUT FILTER: Components used to attenuate output ripple and noise in a power supply.

OUTPUT IMPEDANCE: The ratio of change in output voltage to change in load current.

OUTPUT POWER: The maximum total output power for which the supply was designed to operate.

OUTPUT RANGE: The specified range over which the value of a stabilized output quantity (voltage or current) can be adjusted.

OUTPUT RIPPLE AND NOISE: See Periodic and Random Deviation.

OUTPUT VOLTAGE: The nominal value of the DC voltage at the output terminals of a power supply.

OVERSHOOT: A transient change in output voltage, in excess of specified output accuracy limits, which can occur when a power supply is turned on or off, or when there is a step change in line or load.

OVERVOLTAGE PROTECTION: A power supply feature which shuts down the supply when its voltage exceeds a preset level.

OVP: Overvoltage Protection

PARALLEL OPERATION: The connection of two or more power sources of the same output voltage to obtain a higher output current.

PARD (periodic and random deviation): replaces the former term ripple and noise. PARD is the periodic and random deviation referring to the sum of all ripple and noise components on the dc output of a power supply regardless of nature or source.

PEAK OUTPUT CURRENT: The maximum current value delivered to a load under specified pulsed conditions.

PEAK TO PEAK: The measured value of a waveform from peak in a positive direction to peak in a negative direction.

POLARITY: The ability of a power supply to operate either above or below ground up to a specific voltage.

POTTING: An insulating material for encapsulating one or more circuit elements.

POWER FACTOR CORRECTION: Technique of forcing current draw to approach being in-phase with the voltage in an ac circuit.

POWER FACTOR: The ratio of true to apparent power in an ac circuit expressed as a decimal.

POWER FAIL DETECTION: A power supply option which monitors the input voltage and provides an isolated logic output signal when there is loss of line voltage.

POWER RATING: DC power available at the output terminals of a power source based on the manufacturers specifications.

PPM: parts per million.

PROGRAMMABLE POWER SUPPLY: A power supply with an output controlled by an external resistor, voltage, or digital code.

PROGRAMMING: The control of a power supply parameter, such as output voltage, by means of a control element of a signal.

PULSE WIDTH MODULATION (PWM): A switching power conversion technique where the on-time is modulated to control power transfer for regulating power supply outputs.

RATED OUTPUT CURRENT: The maximum load current that a power supply can provide under specified operating conditions.

RECOVERY TIME: The time required for the measured characteristic to return to within specified limits following an abnormal event.

RECTIFICATION: The process of changing an alternating current to a unidirectional current.

REFERENCE GROUND: Defined point in a circuit or system from which potential measurements are made.

REFERENCE VOLTAGE: The defined or specified voltage to which other voltages are compared.

REGULATION: The ability of a power supply to maintain an output voltage or current within a specified tolerance as referenced to changing conditions of input voltage and/or load.

REMOTE CONTROL: The setting of the power supply voltage, current, or other function by means of an external control quantity such as a variable resistance, voltage, or current, or a digital signal from a computer.

REMOTE INHIBIT: A power supply interface signal, usually TTL compatible, which commands the power supply to shut down one or all outputs.

REMOTE SENSING: A technique for regulating the output voltage of a power supply at the load by connecting error-sensing leads from the load to the regulator.

REMOTE VOLTAGE PROGRAMMING: The ability to change the output voltage of a power supply from a remote location.

RESOLUTION: The smallest change in output voltage or current that can be realized by adjustment of the control signal..

RESONANCE: The state in which the natural response frequency of a circuit coincides with the frequency of an applied signal.

RESONANT CIRCUIT: A circuit in which inductive and capacitive elements are in resonance at an operating frequency.

RESONANT CONVERTER: A class of converters that uses a resonant circuit in the power generating stage.

RESONANT FREQUENCY: The natural frequency at which a circuit oscillates or a device vibrates.

RESPONSE TIME: The time required for the output of a power supply or circuit to recover from a step change in input voltage or load current.

RETURN: The designation of the common terminal for the power supply input or output which carries the respective return currents.

RFI: An abbreviation for Radio Frequency Interference.

RIPPLE AND NOISE: The amplitude of the AC component on the DC output of a power supply related to the internally generated switching frequency, as well as harmonics related to the AC input frequency.

RIPPLE: The periodic ac component at the power source output harmonically related to source or switching frequencies. Unless specified otherwise, it is expressed in peak-to-peak units over a specified band width.

RISE TIME: The time required for a pulse to rise from 10 percent to 90 percent of its maximum amplitude.

ROOT MEAN SQUARE (RMS) VALUE: 1) (periodic function) The square root of the average of the square of the value of the function taken throughout one period (IEEE Std 100-1988). 2) For a sine wave, 0.707 x Peak Value.

SAFETY COMPLIANCE: Certification, recognition or approval by safety agencies such as Underwriters Laboratories Inc. (UL/U.S.A.), Canadian Standards Association (CSA), etc.

SAFETY GROUND: A conductive path to earth that is designed to protect persons from electrical shock by shunting away any dangerous currents that might occur due to malfunction or accident.

SETTLING TIME: The time for a power supply to stabilize within specifications after an excursion outside the input/output design parameters.

SHOCK HAZARD: A potentially dangerous electrical condition that may be further defined by various industry or agency specifications.

SHORT CIRCUIT CURRENT (SCC): The initial value of the current obtained from a power source in a circuit of negligible resistance.

SHORT CIRCUIT PROTECTION: A protective feature that limits the output current of a power supply to prevent damage under short circuit conditions.

SHORT CIRCUIT: A direct connection that provides a virtually zero resistance path for current.

SLAVE: A power supply which uses the reference in another power supply, the master, as its reference.

SLEWING RATE: The maximum rate of change a power supply output can produce when subjected to a large step response or specified step change.

SLOW START: A feature that ensures the smooth, controlled rise of the output voltage, and protects the switching transistors from transients when the power supply is turned on.

SOFT START: A feature which limits the start-up switching currents of a switching supply and causes the output to rise slowly.

STABILITY, LONG TERM: The output voltage change of a power supply, in percent, due to time only, with all other factors held constant. Long-term stability is a function of component aging.

STABILITY: The change in output voltage or current which occurs at constant load, constant input and constant temperature for a given period of time following warm up. This effect is related in part to internal temperature and aging effects.

STEP CHANGE: An instantaneous change in a quantity from one value to another.

STIFF LINE: A condition where there is no significant impedance present in the AC mains feeding input power to a power supply.

STORAGE TEMPERATURE: The range of ambient temperatures through which an inoperative power supply can remain in storage without degrading its subsequent operation.

SWITCHING FREQUENCY: The rate at which the DC voltage is switched on and off during the pulse width. The operating frequency of the high voltage inverter in a switching power supply.

SWITCHING REGULATOR: A switching circuit that operates in a closed loop system to regulate the power supply output.

TEMPERATURE, AMBIENT: The room temperature or temperature of the still air surrounding the power supply, with the supply operating.

TEMPERATURE, COEFFICIENT: The average per cent change in output voltage per degree change in temperature with load and input voltage held constant.

TEMPERATURE RANGE, OPERATING: The range of ambient or case temperatures within which a power supply may be safely operated and meet its specifications.

TEMPERATURE RANGE, STORAGE: The range of ambient temperatures within which a power supply may be safely stored, non operating, with no degradation in its subsequent operation.

THERMAL PROTECTION: A protective feature that shuts down a power supply if its internal temperature exceeds a predetermined limit.

TIME CONSTANT: Time period required for the voltage of a capacitor in an RC circuit to increase to 63.2 percent of its final value.

TRANSIENT RECOVERY TIME: the time interval between a specified step change in the current of a constant-voltage supply or the load voltage of a constant-current supply and the instant when the output returns to its specified value.

UNDERSHOOT: A transient change in output voltage, below output accuracy limits,.

UNDERWRITER LABORATORIES INC. (UL): American association chartered to test and evaluate products, including power sources.

VDE: Verband Deutscher Elektrotechniker. A German organization which tests equipment for public safety and emitted noise.

VOLTAGE DIVIDER: Tapped or series resistance or impedance across a source voltage to produce multiple voltages.

VOLTAGE DOUBLER: See Voltage Multiplier.

VOLTAGE LIMIT: Maximum or minimum value in a voltage range.

VOLTAGE MODE: The functioning of a power supply so as to produce a stabilized output voltage.

VOLTAGE MONITOR: A circuit or device that determines whether or not an output voltage is within some specified limits.

VOLTAGE MULTIPLIER: Rectifier circuits that produce an output voltage at a given multiple greater than the ac peak input voltage, usually doubling, tripling, or quadrupling.

VOLTAGE REGULATION: The process of holding the output voltage cnstant against changes in input voltage and load current expressed as a percent.

VOLTAGE SOURCE: A power source that tends to delivers essentially constant voltage.

WARM UP TIME: The time needed, after turn-on, for a power supply to meet its performance specifications.

WARM-UP DRIFT: The change in output voltage of a power source from turn on until it reaches thermal equilibrium at specified operating conditions.

WARM-UP: Process of approaching thermal equilibrium after turn on.

WATT (W): Unit of measure of power equal to 1 joule/sec. (W=El)

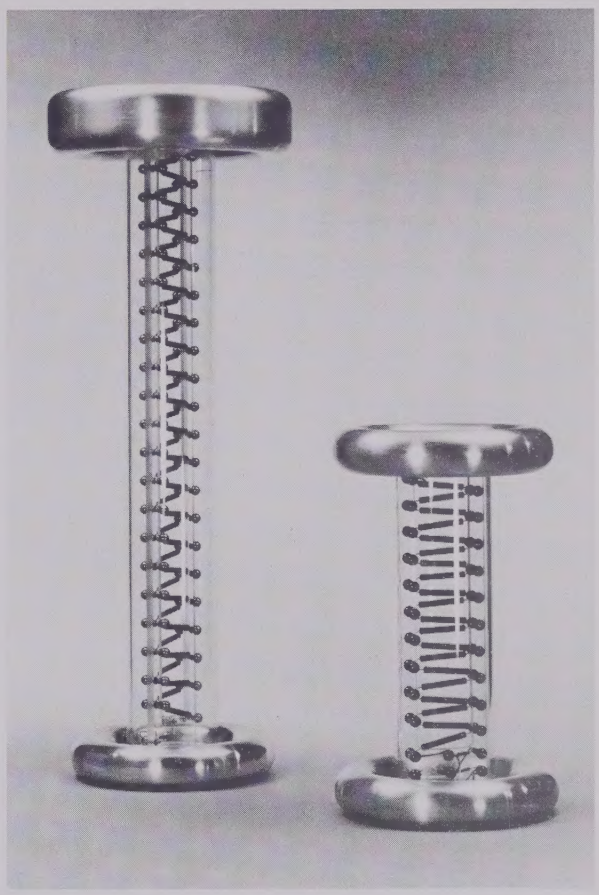
X-RAY TUBE: A vacuum tube designed for producing X-rays by accelerating electrons to a high velocity by means of an electrostatic field and then suddenly stopping them by collision with a target. (IEEE Std 100-1988).

Resistive Voltage Dividers

...for the measurement of high voltages using a standard digital voltmeter

Highlights

- High input impedance
- 0.5% accuracy (higher accuracies available)
- 25 ppm temperature coefficient
- Corona-free operation



Spellman Resistive Voltage Dividers provide laboratory or production facilities with a convenient method for measuring up to 100 kV or 200 kV with accuracy better than 0.5%. The Dividers are designed for use with standard digital voltmeters or differential voltmeters.

The HVD Series dividers are housed in lucite cylinders containing a matched set of precision metal film resistors. These resistors have a temperature coefficient of less than 25 ppm. A ladder-type construction is used in conjunction with polished HV bushings specifically designed to eliminate corona. BNC connectors provide interfacing with standard DVMs.

Specifications

	Model HVD 100	Model HVD 200
Input voltage:	0-100 kV dc	0-200 kV dc
Input impedance:	1000 Mohms	2000 Mohms
Output impedance:	1 Mohm, 100 kohms	10 kohms
Output taps:	100 V, 10 V	2 V
Accuracy:	0.5%; 0.1% opt(1)	0.5%; 0.25% opt(2)
Stability:	0.01%/8 hrs	0.025%/8 hrs
Temperature coefficient:	25 ppm/°C	25 ppm/°C
Size: Height Max. Dia.	17-1/2 in (44.5 cm) 10 in (25.4 cm)	33-1/4 in (84.5 cm) 12 in (30.5 cm)
Weight:	6-3/4 lbs (3.1 kg)	12 lbs (5.5 kg)
Output connector:	BNC type	BNC type

(1) for accuracy of 0.1%, specify HVD100-1
(2) for accuracy of 0.25%, specify HVD200-1

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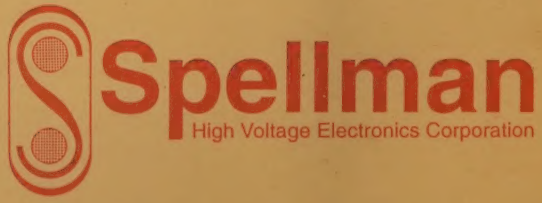

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